Thesis/
Reports
Leonard
Guss

PRODUCT DEMAND CHARACTERISTICS AND MARKET ACCESS FOR SELECTED DEAD SOFTWOOD-BASED PRODUCTS

Prepared in cooperation with
USDA FOREST SERVICE
FOREST PRODUCTS LABORATORY
Madison, Wisconsin
INTERMOUNTAIN FOREST AND RANGE EXPERIMENT STATION
Missoula, Montana
ROCKY MOUNTAIN FOREST AND RANGE EXPERIMENT STATION
Fort Collins, Colorado

By
LEONARD GUSS ASSOCIATES, INC.
4041 Ruston Way
Tacoma, Washington 98402

Cooperative Agreement #16-931-CA
Rocky Mountain Forest & Range Experiment Station
December 21, 1979

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ABSTRACT

Leonard Guss Associates, Inc. was commissioned to review the opportunities for dead softwood timber in the light of the locations of that timber, the kinds of products that could be made from it and the markets in which it could be sold. The emphasis of the desk study was upon reconstituted wood products, and some commentary was requested upon other product possibilities. The products reviewed included structural flakeboards, conventional particleboards, hardboards, medium density fiberboards, and a number of miscellaneous items.

LGA developed information on potential geographic markets for key products, and freight costs from these markets to likely plant locations. Information provided by other Co-operators for the Forest Service was then used to estimate an allowable cost for dead softwood, delivered to a site. Additionally, projections were made of potentially available markets and prices for the year 2000.

Of the reconstituted product possibilities thus assessed, the most promising were waferboard or a closely related structural flakeboard, which generated an allowable delivered wood cost of $34. per ton, and MDF, which generated an allowable wood cost of $31.25 per ton. No other product possibility examined came close to this sum. Of the miscellaneous products reviewed, thermo-mechanical pulp may be a promising possibility but a detailed assessment lay outside the scope of this project, and capital cost and operating cost information must be developed.

PRODUCT DEMAND CHARACTERISTICS AND MARKET ACCESS FOR SELECTED DEAD SOFTWOOD-BASED PRODUCTS

BACKGROUND

The Inland regions of the western United States contain considerable volumes of dead softwood timber. While these include a variety of representative species, Ponderosa pine, lodgepole pine, western white pine, grand fir and spruce are major components of the annual losses. This timber was killed, or is in the process of dying, for a number of reasons, usually insect infestation, but often disease. In its present condition, it presents both an opportunity and a threat to good forest management.

The opportunity derives from the sheer scale of the potentially available material. The area defined as the Inland West ranges between the Cascade Crest in the west and to the edge of the Great Plains in the east, while running south from the Black Hills to include the large timbered area of the Southwest. Previous and current research conducted or sponsored by the Forest Service has shown that this dead timber may be utilized in a number of ways, which are unaffected by the manifestations of the insect infestation or other process which killed it. As a result, Forest Service management is already operating under programs designed to recover the maximum values available as lumber or veneer. Further utilization possibilities fall into the grouping of reconstituted products. In such products, the timber is comminuted or reduced to a fibrous or particulate state during which rot, speck, or any other defect which renders the material less or unsuitable for lumber or veneer is removed, or so distributed that it does not affect the usefulness of the raw material for the purposes of reconstituted products.

The threat derives from the fact that the standing dead softwood timber is a hazard of itself, susceptible to fire, and a source of spreading infestation. Moreover, the current limited utilization of this dead standing timber represents a potential waste of fiber at a time when the Forest Service and private timber managers are especially concerned with increasing fiber removals and utilization to meet growing demands and to provide for a future which is reasonably

projected to require considerably greater volumes of forest products than are now produced and sold. There are definite time limits to dead softwood utilization. As a rule of thumb, such timber may be harvested and used for up to five years, although there is significant deterioration during and after the third year, while some usable fiber may remain even after five years have passed. Finally, a dead forest, or a preponderance of dead trees in a forest limits the regrowth of that acreage's growing stock, and limits the multiple use considerations normally available in a living forest - few find recreational pleasure in stands of dead timber.

For these reasons, the Forest Service was interested in exploring the options open to it in encouraging the utilization of the dead timber resource. Leonard Guss Associates, Inc. was assigned the task of preparing a report which would provide the National Forest Managers with guidance in encouraging fuller utilization of this material. Whether or not largescale utilization of dead timber in reconstituted board occurs depends on the marketability of the products made from it in competition with similar products made elsewhere. This marketability will depend on product characteristics and on obtainable price, the latter being limited by competition. The obtainable price at the mill will then set the limits on what can be paid for raw material. The question to be resolved is whether the economics involved are favorable, that is, whether product markets and product prices are such as to allow the removal and utilization of dead softwood timber for reconstituted panels in the Inland West.

TECHNICAL FEASIBILITY

The physical capability or limitations that the use of dead softwoods involves for the several product possibilities under study are of obvious importance. The development of such information was not a part of this assignment. Rather, the Consultant obtained and reviewed all available information dealing with this important subject, which included papers on work done by Colorado State University, Washington State University, the Rocky Mountain Forest and Range Experiment Station, the Pacific Northwest Forest and Range Experiment Station, Oregon State University and the Forest Products Laboratory.

These sources are listed in the Bibliography, Appendix A.

A good summation of the technical review is to be found in the abstract of the paper by Troxell, et al, cited in the bibliography:

> Many characteristics of mountain pine beetle-killed ponderosa pine are little different from those of ponderosa pine harvested when live. Differences are that the beetle-killed timber is drier, is usually blue-stained, may contain wood-borers, and may contain decay. Except for toughness, which may be reduced as much as 50 percent in beetle-killed timber, strength values are only slightly reduced.

So far as market acceptance is concerned, the most important negative attribute of dead softwood seems to be the pervasive blue-stain, since this produces a reconstituted panel which is grayish blue in color. LGA has taken this into account in the sections dealing with market acceptance of such products. The other negative attributes are unlikely to affect market acceptance per se; rather they will be reflected in somewhat higher wood costs because they tend to reduce the percentage of useable fiber.

Other work (Markstrom, et.al.) has indicated that any particleboard from ponderosa pine from the Black Hills area of South Dakota, may require a somewhat higher resin adhesive content than other softwoods, including ponderosa pine from other regions. This is not attributable to the presence of dead pine raw material, but to the nature of the pine grown here. The net effect is a somewhat higher manufacturing cost than for equivalent boards made elsewhere.

LOCATION AND VOLUMES OF DEAD SOFTWOOD TIMBER

No agency has deveoped a comprehensive survey of the total volume of dead softwood timber in the West. Scattered data indicate that at least 3.2 billion board feet of timber if lost annually in Wahsington, Oregon, and California alone, while additional volumes are lost in the Mountain states. Data presented at a symposium on the dead softwood timber resource in May, 1978, indicated that an

estimated 3.1 billion cubic feet of rough and rotten timber exists in the Inland region, together with another 6.3 billion cubic feet of salvageable dead timber.

The dead softwood timber is not uniformly spread throughout the West, but is concentrated by species and location. Lodgepole pine and western white pine are among the hardest hit, while additional stands of ponderosa pine and Engelmann spruce are also devastated. Figure 1 shows some of the concentrations of dead timber in the West.

OBJECTIVES OF THE STUDY

1. Characterize major national and regional end-use markets, including related export markets, within which dead softwood based products may compete. Study will be directed to the identification and/or estimation of market size, pricing structure, distribution channels, functional use requirements, and requirements for competitive marketing of dead softwood based products.

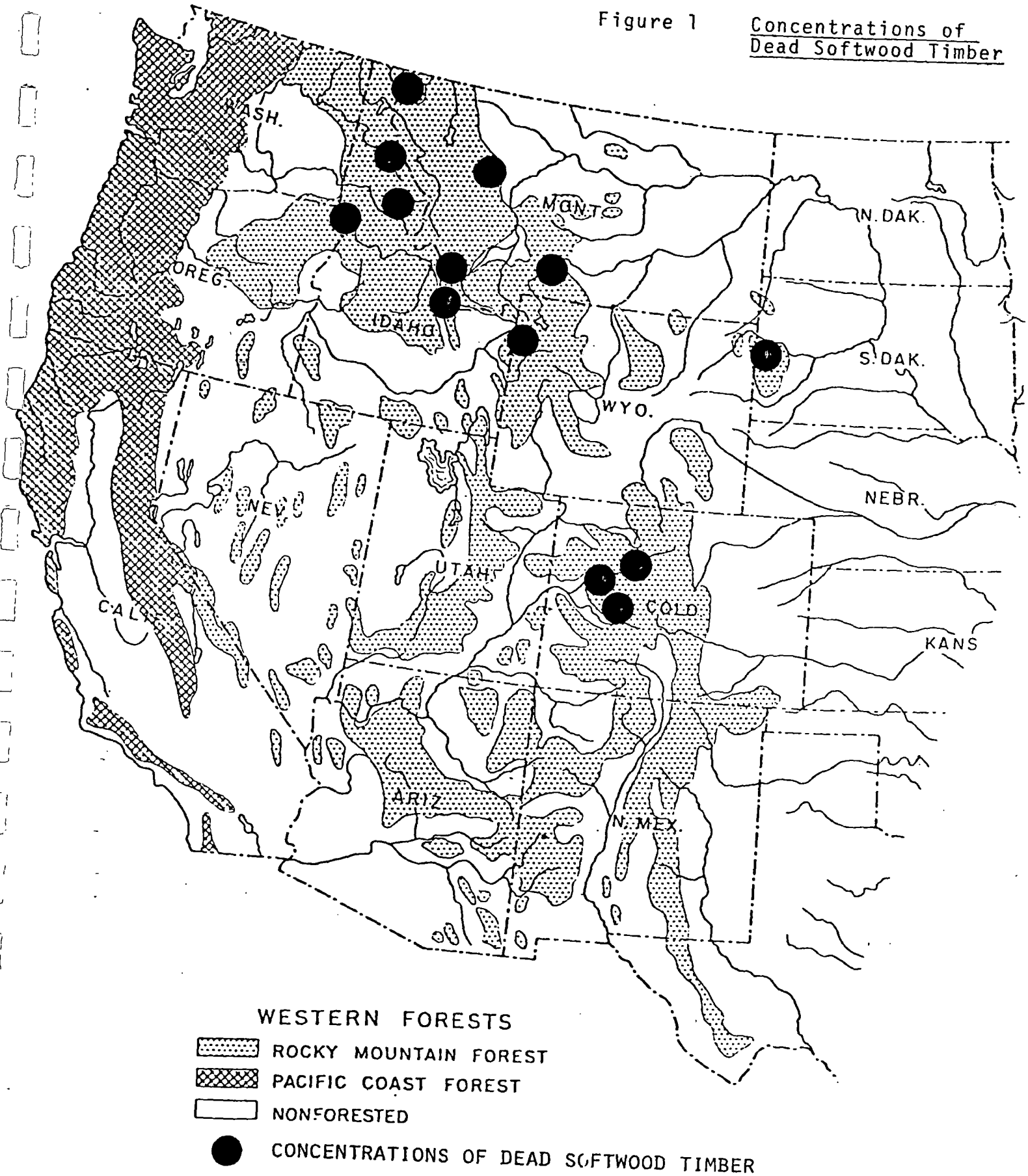
2. Determine transportation costs for each selected products when delivered by conventional modes to product distributors and end users in a selected number of major trading areas throughout the United States, from representative production points in the Inland West, and compare these on a relative basis with transportation costs for competitive products produced elsewhere.

3. Depict advantages or disadvantages Inland West producers could expect in competing with producers from other regions, particularly with respect to product characteristics, production costs, and freight costs.

4. Project market volume and price trends for each of the selected products to the year 2000.

5. Schedule the projected market demand for each potential dead softwood-based product to the year 2000, disaggregated to show probable marketability of the product if produced in the Inland West.

Figure 1 Concentrations of Dead Softwood Timber



SCOPE

The scope of the study included initial consideration of a number of products and product classes:

- underlayment particleboard
- industrial grade particleboard
- mobile home deck
- structural flakeboard
- structural waferboard
- structural particleboard
- medium density fiberboard
- medium density siding
- dry process hardboard
- thermo-mechanical pulp
- energy
- overlaid reconstituted board products (veneer or paper)
- thin board
- particleboard molded products

The focus of the study was on the market feasibility of producing these products in a dead softwood region.

METHODOLOGY

The study was intended to be a desk analysis, based on information on hand in the Consultant's files or readily available from published and unpublished private and governmental sources. LGA reviewed such information as developed by the U.S. Forest Service, Bureau of the Census, various trade associations, publications and its own extensive files.

Additionally, LGA team members visited three U.S.F.S. Forest and Range Experiment Stations (Pacific Northwest, Rocky Mountain, and Intermountain), as well as the Washington State University, and the University of Montana, and the Forest Products Laboratory. At each of the above, intensive discussions were held with Forest Service and university personnel, who have worked on the subject of the dead softwood resource. The information and material provided to the Contractor as a result of these meetings was most helpful in orienting the study.

LGA also utilized the services of an organization which provides freight rate and tariff information to wood products industry members, to generate current and applicable freight information used in the study. As a comment, this task proved unforeseeably difficult, in view of the many and confusing changes of recent occurence in both rail and truck tariffs, due to escalating fuel costs.

Finally, LGA project members made a number of personal and telephone interviews with knowledgeable industry persons and organizations to obtain information not otherwise available.

Wherever possible, LGA has based its own segment of the dead softwood analysis on information developed by other cooperators and Forest Service sources, e.g. information on capital and operating costs for reconstituted product mills. While LGA is most appreciative of the help, information, and guidance provided by Forest Service personnel, especially the official technical representatives for this project, Mr. John B. Grantham succeeded by Mr. George Harpole, and other members of the review committee (Messrs. Roland L. Barger, Harold E. Worth, Henry Spelter, and Thomas Maloney), we wish to state that the conclusions of the work, and the accuracy of any calculations made therein are the sole responsibility of LGA.

WAFERBOARD AND OTHER STRUCTURAL PARTICLEBOARDS*

DEVELOPMENT

Currently, conventional platen particleboards made in the U.S. from residues and using urea resins are not usually structural products, which are defined as having to "reasonably match construction plywood in its properties, including resistance to water." One or two of the conventional particleboard plants in the United States do produce an exterior structural particleboard which, in effect, meets or exceeds the U.S. Department of Commerce standards, CA-236-66, Type 2-B2. Such products have never been provided in significant volume, nor achieved more than a localized and minor acceptance for structural applications, primarily as sub-floor.

Waferboard was the first true structural particleboard. The special particles, or large flakes, used in its manufacture were called "wafers" by the originator of the product, James d'Arcy Clark. The exterior and structural properties of the product are partially due to the use of wafers and partially to the phenolic resins used as binding agents. The term "waferboard" was adopted by the Canadian industry in order to differentiate the product from the then better known interior, industrial grade "particleboards" and "flakeboards," which are made with urea formaldehyde binders. A term that is receiving increased currency for the generic structural composition board is **structural flakeboard.**

The first waferboard plant was built in 1956 at Sand Point, Idaho, by Clark and the Pack River Lumber Company, and used local softwoods. Due to the abundance and low price of softwood plywood in those days, the product found only limited acceptance. Since the plant was located in the vicinity of the large softwood plywood manufacturing plants of the Pacific Northwest, it had no basic cost advantage against the well-established softwood plywood industry. At any rate, this plant was not a financial success although it did operate on a curtailed basis up to about 1974.

* The accepted terminology for the entire class of materials is still somewhat in a state of flux. Terms employed also include structural flakeboard and structural composition board.

A second waferboard plant, using hitherto almost unutilized aspen as raw material, was also built by Clark for a small company, called Wizewood, at Hudson Bay, Saskatchewan, in 1961. This company, too, encountered financial difficulties which were partially due to marketing obstacles but also aggravated by technical problems at the plant. Eventually, the company was taken over by the Saskatchewan Government, which had financed the plant.

Under the Government's regime, some technical changes were made which resulted in improved product quality and plant output. By 1966, the waferboard product gained considerable recognition and acceptance, mainly in farm building applications in the Prairie markets. The exterior and structural properties of waferboard were also substantiated by these field applications. In 1967, the Government of Saskatchewan was able to sell the plant to MacMillan Bloedel. The new owner enlarged the plant and put considerable developmental emphasis into the product (trade named Aspenite).

Under M&B's management and boosted by M&B's sales efforts, waferboard experienced a steady growth in the Canadian markets. Based on this growing acceptance, M&B more than doubled the capacity of the Hudson Bay plant in 1969.

In the late sixties and early seventies, the Hudson Bay plant enjoyed a distinct cost advantage against western softwood plywood manufacturers relative to the central and eastern Canadian markets, partially due to the location of the plant and also due to the low cost of aspen roundwood during that period. Encouraged by the growing sales of waferboard and the obvious cost advantages against western plywood, several other companies embarked on new plants in the early Seventies. In chronological order, these were: Waferboard, Limited, at Timmins, Ontario (1973), Weldwood at Long Lac, Ontario (1973), MacMillan-Bloedel at Thunder Bay, Ontario (1975) and Great Lakes Paper at Thunder Bay, Ontario (1975). Blandin Paper Company in Grand Rapids, Minnesota, built a large waferboard plant in the United States. The Blandin plant which was scheduled to start up in 1974 encountered serious technical difficulties and did not enter the market in any volume until the latter part of 1976. The last plant

built during this period was Alberta Aspen Board, Limited, at Lesser Slave Lake, which operated in 1976 and closed that same year due to marketing and production difficulties.

This large expansion of Canadian waferboard plant capacity proved to be ill-timed. The economic turmoil caused by the oil crisis in 1973-4 collapsed the building products markets in 1975 and 1976. In addition, resin prices more than doubled during this period. The sharp increase in resin prices penalized waferboard costs to a much greater extent than plywood costs. As a result, all of these new plants were forced to start up in poor markets and at a reduced cost advantage.

Waferboard Limited at Timmins, Ontario, started up in January of 1973 and enjoyed almost two years of favourable markets. This, coupled with the fact that the Timmins plant enjoyed the best location relative to the large Quebec and central Ontario markets enabled it to survive the 1975-76 market slump. The plants at Long Lac and Thunder Bay had, of course, sufficient financial backing from their strong parent companies. The Alberta plant, having the least advantageous location and the weakest financial position, was forced into receivership in 1976.

The Canadian consumption of waferboard in 1976 was about 220 MMsf 3/8" whereas Canadian plant capacity was on the order of 500 MMsf 3/8", not counting the capacity of the Alberta Aspen Board plant. It was obvious that the Canadian market could not absorb such a sharp increase in production. The potential of the U.S. market appeared to be more promising. As a result, both M&B and Weldwood initiated strong sales efforts to market the product in the North Central and Northeastern regions of the United States.

In marked contrast to Canada, the United States, despite its enormously greater potential, had been relatively indifferent to structural flakeboards. The existence of a well developed softwood plywood industry, the lack of pressing need to utilize the aspen raw material well suited for this product, and a

reluctance to adopt Canadian technology, all held back development. There had been, however, intense interest at the study level on the part of private companies and the United States Forest Service all of whom conducted, and sometimes published, considerable research.

Waferboard from Canada appeared in the United States as early as 1967, in some test houses developed by Florida Power and Light Company, used there as subfloor in a non-code application. Additional volumes were sold by Blanchard Lumber (now part of MacMillan-Bloedel) in the Northeast, with no particular problem, until 1972 when the sole supplier, M&B, went on allocation in Canada and withdrew the U.S. supply. Significant shipments to the U.S. did not resume until 1975, when both M&B and Weldwood shipped considerable quantities to the U.S., the former through Blanchard and the latter through its affiliate, the U.S. Plywood Company. In 1976 these firms were joined by (sporadic) U.S. production, and towards the end of the year, volume from the other Canadian producers.

The export effort of the Canadian plants was aided by two somewhat unexpected events. First, the Canadian dollar dropped to 90¢ U.S., partially negating and later, more than negating the 10 percent duty costs on exports to the United States , as the ratio of Canadian to U.S. dollars dropped still more. Secondly, and probably more importantly, the U.S. building codes permitted the use of 3/8" thick plywood in roof sheathing.

Because waferboard has a lower breaking strength than sheathing grade softwood plywood, both Canadian and U.S. codes specify that waferboard has to be 1/16" thicker than plywood in load bearing applications over a two foot span, such as roof decking. In Canada, 3/8" thick plywood was always accepted as the norm in the roof decking application; consequently, 7/16" waferboard was forced to compete with 3/8" plywood for the roof deck market. **In order to achieve initial market penetration, 7/16" waferboard was sold below the price of 3/8" plywood, and this price relationship never really changed.** As a result, most of the waferboard in Canada was sold as a utility board in 1/4" and 5/16" thicknesses and was sold to the shoulder trade through retail outlets. The penetration into the roof deck and wall sheathing applications in single and multi-family home

construction does not amount to more than 20 to 25 percent of the total Canadian waferboard consumption (about 40 to 50 MMsf 3/8").

In the United States, builders are used to 1/2" plywood on the roof. The 3/8" thickness did not find great overall acceptance, mainly because it proved to be (or was perceived to be) to "whippy" or "bouncy" during installation. As a compromise, some builders turned to 7/16" waferboard, which is stiffer on the roof than 3/8" plywood and significantly cheaper than 1/2" plywood. In the U.S. therefore, waferboard found itself competing with 1/2" rather than 3/8" plywood and managed to establish a price level for 7/16" waferboard roof deck slightly above the delivered price of 3/8" plywood both in the U.S. Midwest and Northeast.

Because it did not, at first, meet Canadian or U.S. housing codes, earlier waferboard production was concentrated in thinner grades, and used for non-code construction, as fencing, and as a general utility panel. As code requirements were increasingly met, more and more waferboard was used for wall and roof sheathing and related purposes, even though a somewhat thicker material than plywood had to be used to cover the same spans. Over time, and as experience was gained, these requirements were made less stringent so that, in many cases, either equivalent thicknesses to plywood are accepted, or only small increases in thickness are required.

These factors coupled with a sharp increase in housing starts in the U.S. starting in late 1976 gave Canadian waferboard exports a tremendous boost. In 1978, Canadian waferboard shipments reached a level of 510 MMsf 3/8", 50 percent of which was exported to the U.S.

Currently, all operating Canadian firms ship to the U.S. market. Weldwood and M&B still retain the company owned or related channels of distribution; M&B sells the output not only of its two plants, but Great Lakes' as well. Waferboard, Ltd. sells some material to northern Northeast states (northern New York in particular) through independent wholesalers.

The sole U.S. waferboard plant in operation even today is Blandin, which was recently purchased by B.C. Forest Products. Although this plant had suffered severely from production difficulties in the past, it is now operating at its design capacity.

Table 1 recapitulates the shipments of market waferboard.

Table 1
SHIPMENTS OF MARKET WAFERBOARD MILLS
1972-1978

	Operating Mills	Shipments (3/8" basis, Million sq. ft.)	United States Consumption
1972	1	110	small
1973	2	118	small
1974	4	131	small
1975	5	266	50
1976	7	380	150
1977	6	515	300
1978	6	590	335

SOURCE: Leonard Guss Associates, Inc. estimates

Other Structural Reconstituted Panels

There are other structural reconstituted panels made in the United States. Redex, made by Louisiana-Pacific, Arcata, California, is a conventional particleboard made from mill residues, using phenolic resins; it has already been mentioned. The only other fully operating U.S. plant uses a concept developed by the Elmendorf Corporation, called "Oriented Strandwood" in which flakes similar to but narrower than those used in waferboard are cut, but instead of being randomly oriented, are directionally oriented. This significantly increases the physical strength in the oriented direction without seriously diminishing it in the cross section.

However, the first plant of this type does not produce board for market. Instead, the product is manufactured by Potlatch Forest Industries as a corestock for softwood veneer. When overlaid with these veneers, the resulting composite panel is sold by PFI as a structural board (trade named Plystran).

Finally, the Champion International Company manufactures its own variant of a structural panel, trade-named Novaply. This product is made of small flakes and mill residue-derived particles, and incorporates a phenolic resin to provide exterior properties.

At this writing, two classes of structural reconstituted panel products are emerging. One consists entirely of wafers, or large flakes or strands, although several different geometries and configurations are involved, depending on producer. Other panels comprised of reconstituted wood, such as particleboard or smaller-flake boards are being abandoned in favor of the waferboard types. LGA will therefore treat only of waferboards and similar products in this section, and considers that the other structural panel variants made entirely of reconstituted particles will eventually disappear from the market or, at best, have a minimal presence and impact. Moreover, despite manufacturers' contentions, LGA sees little likelihood that the markeplace will make sharp distinctions with price differentials. Therefore, for the purposes of this discussion, all wafer-derived boards will be considered alike.

The other class of product involving reconstituted panels is the composite panel, in which the reconstituted portion is used only as the core in a plywood, replacing the lowgrade veneer formerly employed for this purpose. Since this product is conceptually closer to softwood plywood than to a reconstituted panel, it is not included in the scope of this study and will not be dealt with beyond the inclusion of current or planned production of such products in Table 2 and 3.

Production of Structural Reconstituted Panels

Lately, the increased imports of waferboard from Canada, the high prices required for plywood and a pending shortage of peeler grade logs in the United

States have created a great deal of interest in waferboard and other types of exterior, structural grade reconstituted wood products.

The opportunity to export to the United States, coupled with the desire of the provincial governments to utilize the aspen resource, has created considerable interest in additional waferboard plant construction in Canada as well, despite some fears of overcapacity.

The result has been an almost explosive growth in announced U.S. and Canadian plants, many of which are now under construction.

Table 2 shows the currently operating structural particleboard plants in North America.

Table 3 enumerates those structural particleboard plants which are either under construction or planned, including expansions. The large number reflects the intense interest being shown as the concept has proven itself. This table includes composite boards and waferboards. See Figure 2, also.

Table 2

OPERATING STRUCTURAL PARTICLEBOARD PLANTS IN NORTH AMERICA

1979

CANADIAN PLANTS	ANNUAL CAPACITY MILLION SQ. FT. 3/8"
MacMillan-Bloedel Hudson Bay, Saskatchewan	125
Waferboard Corporation Timmins, Ontario	65
MacMillan-Bloedel Thunder Bay, Ontario	100
Weldwood of Canada Long Lac, Ontario	100
Great Lakes Paper Thunder Bay, Ontario	100
Northwood Chatham, New Brunswick	130
U.S. PLANTS	
Blandin Wood Products Grand Rapids, Minnesota	85
OTHER STRUCTURAL PARTICLEBOARDS	
Louisiana-Pacific (Redex)	n.a.
Potlatch Forest Industries (Plystran)	100

SOURCE: LGA estimates

Table 3

STRUCTURAL PARTICLEBOARD PLANTS

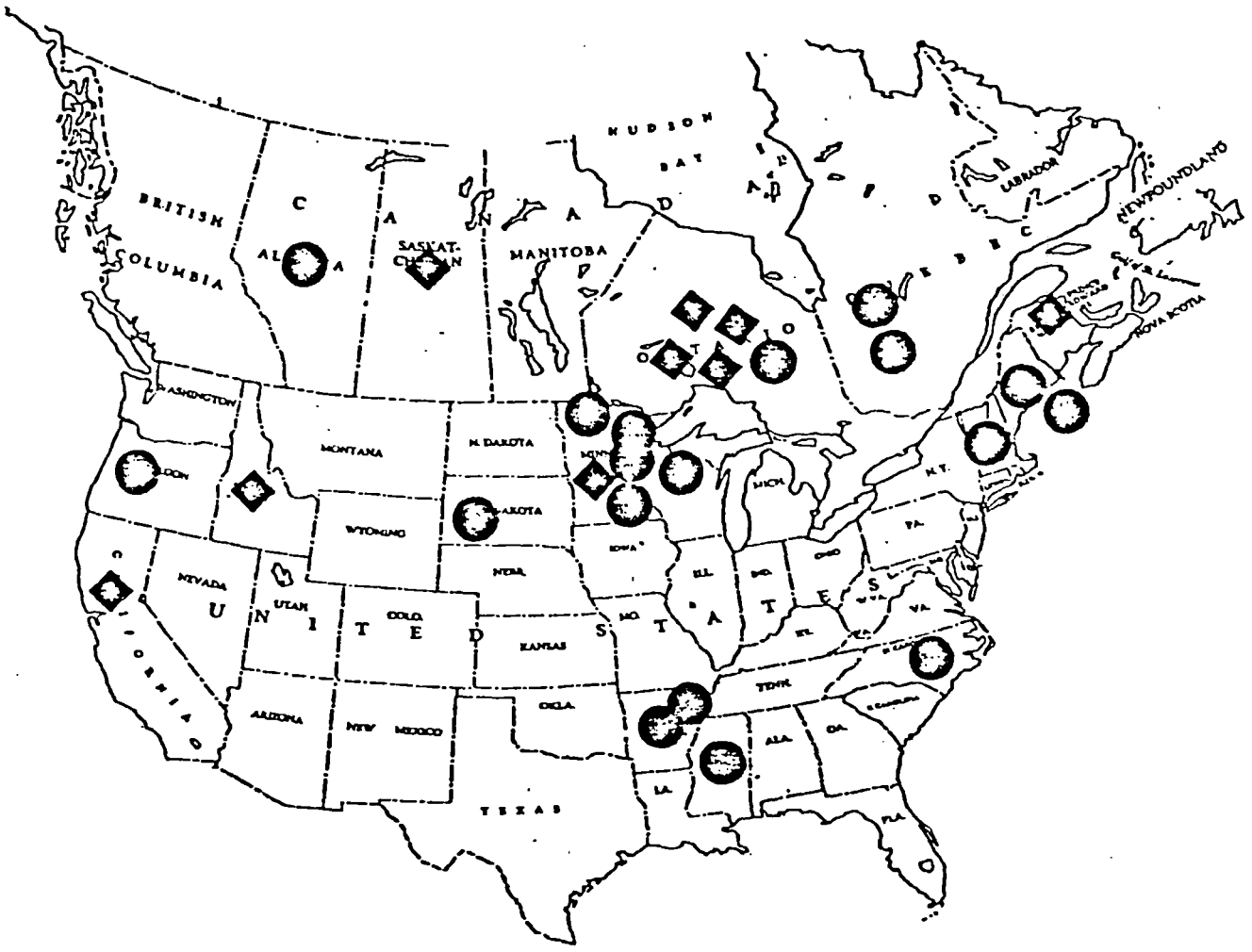
UNDER CONSTRUCTION OR PLANNED

PLANT	PRODUCT	CAPACITY (million sq.ft. 3/8")
Weldwood, Alberta Aspenboard Great Slave Lake, Alberta	waferboard	95
Louisiana-Pacific Hayward, Wisconsin	waferboard	150
Louisiana-Pacific Bemidji, Minnesota	waferboard	170
Potlatch Forest Industries Hibbing, Minnesota	oriented waferboard	150
Potlatch Forest Industries Bemidji, Minnesota	oriented waferboard	150
Blandin expansion/rebuild Grand Rapids, Minnesota	waferboard	150
Northwood Bemidji, Minnesota	waferboard	160
Norwick Perron La Serre, Quebec	waferboard	50
Millet Trois Rivers, Quebec	waferboard	100
La Freniere Chableau, Ontario	waferboard	100
Georgia Pacific Woodland, Maine	waferboard	166
Georgia Pacific Dudley, North Carolina	composite board oriented waferboard core	200
Georgia Pacific Taylorsville, Mississippi	composite board oriented waferboard core	?
Ellingston Timber Baker, Oregon	composite board	60
Elmendorf Claremont, New Hampshire	oriented waferboard	76
Unannounced but under consideration:		
Weyerhaeuser Brainerd, Minnesota	oriented waferboard	?
Celotex Malvern, Arkansas	?	?
Diamond International Maine	waferboard	120-150
B.H. Development Hill City, South Dakota	waferboard	100

SOURCE: LGA estimates

FIGURE 2

LOCATION OF PRESENT AND ANNOUNCED
MARKET WAFERBOARD AND OTHER
STRUCTURAL PARTICLEBOARD PLANTS - 10/1/79



PRESENT PLANTS

ANNOUNCED OR UNDER STUDY

MARKETS AND APPLICATIONS

Residential Construction

Residential construction forms the cornerstone for wood structural panel requirements. For example, in 1978, new residential construction directly consumed more than 8 billion sq. ft. 3/8" of softwood plywood, or 42 percent of U.S. production.

The demand for housing is a result of many interacting forces: family formations, the state of the economy, birthrates, (especially for second and third children), population shift, rising income and expectations, withdrawals from the housing stock due to fire, urban renewal, highway construction and the like, the cost and availability of construction financing and long-term mortgage financing, changing consumer tastes, preferences and life-styles, and recently, the expectation of sharply rising prices encouraging a decision to buy a house before inflation makes it impossible.

Single-family on-site housing represents the traditional pattern of American housing and at one time (Table 4) comprised by far the bulk of residential construction. In recent years, the share of single-family dwellings had dropped steadily, due to rising costs of land, labor, and money and, just as important, changing lifestyles and a changing population in demographic makeup. As a result, single-family housing dropped to a low of 43 percent of all on-site housing in 1971. And even this housing had changed dramatically in nature. Much of it was on smaller plots, smaller in floor area, or had common walls (townhouses, row houses) --- all in response to the cost pressures already noted. In the last 4 years, the share of single-family housing rose again, to about two thirds of the total housing mix. However, even more significant is that in the last five years, houses have gotten larger, as and perhaps, because they have gotten more expensive (See Table 5).

Multi-family dwellings in the early 1950's were often center city, highrise buildings in the style of the 1920's. The tremendous upsurge in multi-family

Table 4

NEW HOUSING BY TYPE OF STRUCTURE, SELECTED YEARS (THOUSAND UNITS)

			CONVENTIONAL HOUSING STARTS							
	NEW HOUSING		TOTAL		1 & 2 FAMILY		3 OR MORE		MOBILE HOME SHIPMENTS	
YEAR	UNITS	%	UNITS	%	UNITS	%	UNITS	%	UNITS	%
1950	1,908	100	1,908	100	1,692	89	216	11	---	--
1970	1,863	100	1,465	79	862	46	603	33	398	21
1971	2,591	100	2,084	81	1,215	43	869	38	507	19
1972	2,952	100	2,377	81	1,384	47	993	34	575	19
1973	2,625	100	2,058	78	1,191	45	867	33	567	22
1974	1,682	100	1,353	80	928	55	425	25	329	20
1975	1,384	100	1,171	85	932	67	239	18	213	15
1976	1,975	100	1,547	86	1,162	65	375	21	246	14
1977	2,260	100	1,990	88	1,513	67	477	19	270	12
1978	2,351	100	2,021	86	1,496(1)	64	525(2)	22	330	14

(1) 1-family = 1,432.8
2-family = 62.6

(2) 3&4-family = 62.9
5-family = 461.7

Table 5

CHANGES IN PRICE AND FLOOR AREA OF SINGLE-FAMILY HOUSING, 1972 - 1978

MEDIAN PRICE [1]	1972[3]	1973	1974	1975	1976	1977	1978
(Current Dollars)	$27,600	$32,500	$35,000	$39,300	$44,200	$48,800	$55,600
Average Floor Area[2]	1,555	1,660	1,695	1,645	1,700	1,720	1,755

(1) At the median, half the houses built for sale fall below and half above the price. However, those priced below actually tend to group rather closely to the median, while those priced above range much higher. Thus, the average price tends to be considerably above the median price.

(2) Since we are concerned with materials use, "average" is a better measure than "median."

(3) For the period 1966-1972 housing prices were relatively stable, rising perhaps 4-5 percent per year, on average; housing inflation took off in 1972 so that, by 1978, the average house cost just about doubled. It is questionable whether any significant physical improvement was obtained for the money.

SOURCE: BUREAU OF THE CENSUS

building in 1969-73 was in suburban and ex-urban locations, heavily weighted to lowrise and garden-style apartments. Such dwellings appeal to population segments who are not yet ready to undertake the responsibility of single-family dwelling or who prefer less involvement with housing, or who have special needs or wish to live with common-interest types of groups.

Mobile homes were officially recognized as housing only in the last few years. The growth in this form of shelter (85 percent of units produced by mobile home manufacturers are for housing, the balance for offices and temporary structures) had been spectacular in recent years, accounting for about one-fifth of all housing. But in the recession of 1974-75, mobile homes, often bought by the population segments hardest hit by recession, dropped to levels of a decade ago, and are just now recovering.

Housing projections for the future are affected by considerations of housing need and demand, by the influence of Federal legislation and policy, and by the availability of the primary constituents of land, labor, money, and materials.

All demand factors and housing forecasting models seem to agree that substantial, continuing demand for housing exists over the next decade, despite the inevitable contraction of the near term future in response to unprecedentedly high interest charges and lack of available mortgage funds.

The balance of homebuilding is shifting somewhat to follow the shifting United States population. People are moving from the older areas of the country to new areas, usually where the living is more pleasant. For example, in the late 1960's and early 1970's a shift occurred to the South, the sunbelt. More recently, there has been an increased swing to the West. Table 6 shows how these shifts have occurred in recent years.

Non-Residential Construction

Non-residential building construction in the United States declined steadily since the surge of the 1972-73 period, and the overbuilding that emerged resulted. A

Table 6

U.S. FIXED SITE-HOUSING STARTS, BY REGION, SELECTED YEAR

(percent)

	1971	1973	1975	1977	1978
Northeast	13	14	13	10	12
North Central	21	21	25	25	23
Southern	42	44	38	39	36
Western	24	21	24	26	29
TOTAL (000 units)	2,084	2,058	1,171	1,990	2,021

SOURCE: U.S. Department of Housing and Urban Development - 1971 -1978

number of factors acted to depress the building economy: there is, or at least was, in many areas, a surplus of space in commercial office buildings; the changing demographics of the U.S. population have seen fewer school children and thus reduced need for all sorts of school buildings; the end of the Vietnam war removed the incentive for many young men to attend college, and so college enrollments are reduced; the relatively poor economy of the 1974-early 1975 period decreased interest on the part of many manufacturers to increase capacity until capacity in place was better utilized; sheer escalation in cost of all non-residential building construction, possibly the hardest hit by inflation of all economic subsegments in the country, itself discouraged many buildings for private or public purposes, including religious, social, commercial, or other uses.

Table 7 shows the expenditures for non-residential buildings in the recent past in terms of current and constant dollars. What may seem to be an increase in expenditures on a current dollar basis was actually, at best, a static situation, at worst, an actual decline. There was a consequent decline in building materials usage.

Table 7

NON-RESIDENTIAL BUILDING CONSTRUCTION, 1973-1978

(Billion Dollars)

	Private		Public		Total	
Year	Current Dollars	Constant Dollars	Current Dollars	Constant Dollars	Current Dollars	Constant Dollars
1973	$27.6	$25.6	$13.0	$12.0	$40.6	$37.6
1974	29.6	23.0	15.0	11.7	44.6	34.7
1975	26.4	19.1	15.3	11.0	41.7	30.1
1976	26.1	18.8	13.2	9.5	39.3	28.3
1977	28.7	19.4	12.8	8.6	40.4	27.4
1978	32.3	19.6	13.9	8.5	46.2	28.1

SOURCE: Construction Review, and LGA estimates

However, LGA sees evidence of change in this picture of recent decline. There has been an increasing deferment of needed expenditure, especially in the public sector. Also, much private capacity has reached the point of needed replacement, a replacement which is encouraged by the relatively good years 1976-78. LGA believes 1977 was the low point of non-residential buildings, and 1978 pushed up a bit; the outlook for future growth, although clouded in the near term, is good over the next two decades.

In addition to the materials actually consumed in a structure, additional opportunities exist for construction fencing, temporary office structures on construction sites, concrete forming, shoring, and similar applications.

Consumer Markets - Repair and Remodeling

Another significant market for structural panels is the repair and remodeling of residential properties, primarily by owners, but also by and for rental units. The Bureau of Census reported annual expenditures in 1973 at $18.5 billion; these expenditures for maintenance, repairs, alterations, etc. had increased to $37.5 billion by 1978. Some of this growth is due to increasing prices for materials, but more reflects a substantial additional volume of products.

The very large direct consumer purchase market includes both do-it-yourself and small contractors, or shoulder trade purchases, for a wide variety of tasks about the house. These range from minor repair to rather substantial remodelings and additions. Much of these expenditures are for fairly definable reasons: re-roofing, re-siding, painting. But very significant sums are not separable into clear-cut categories.

The reasons for growth of the after-market are many. They include the high cost of new housing, the difficulty of finding (or affording) conventional repair or remodeling contractors, the increasing degree of and pride in home ownership, the increasing affluence of our society and, to a large extent, the wide variety and attractiveness of products offered to this market, especially designed for amateur installation. Wall paneling, tile flooring and ceilings are cases in point;

these products have not so much satisfied as created their markets. Structural panels, largely plywood but including waferboards, play a role here, too, for everything from house-related construction to toys, hobbies, outbuildings and the like.

Access to these markets comes through the retail building material supplier which, today, includes not only the traditional lumber yard, but also the mass merchandisers oriented to the DIY market and the paneling display stores. The recent growth of DIY oriented retail building material stores, open 7 days a week, with items pricemarked per piece, has stimulated this market.

An estimate of the retail building material dealer sales by region is provided in Table 8. The retail building supply firm is the only source accessible to the consumer or small contractor for repair materials. Larger contractors frequently can deal direct with building material wholesalers. However, the retailer serves as a source of supply for both the repair and remodeling market and new construction.

Table 8

RETAIL BUILDING MATERIAL SALES BY REGION, 1978

Region	Billion $	Percent
New England	1.8	6
Mid-Atlantic	4.1	12
NORTHEAST	5.9	18
East North Central	6.1	19
West North Central	3.1	9
NORTH CENTRAL	9.2	28
South Atlantic	5.6	17
East South Central	2.2	7
West South Central	3.1	9
SOUTH	10.9	33
Mountain	2.4	7
Pacific	4.6	9
WEST	7.0	16
TOTAL U.S.	33.0	100

SOURCE: Survey of Buying Power - Sales & Marketing Management

Industrial markets

Industrial markets for structural panels are diverse and subject to different economic influences and trends. This section will cover some of the major changes occurring in these markets.

A. Transportation and Materials Handling

The number of new rail freight cars being built in the latter part of the 1970's is at a lower level than it was in the 1960's. Further, the overall number of freight cars available continues to decline in the 1970's, a trend that started in the 1950's. There is an offsetting factor in that most of the newer cars are larger than the older ones. However, the railroads are in dire financial straits, and are minimizing their spending for any equipment, including freight cars. In any event, many of the new box cars are of single wall (all steel) construction with no lining materials utilized in their construction.

The truck industry has been steadily growing at the expense of the railroads, and, consequently, the amount of equipment acquired by truck lines is continuing to increase. There was an extensive bulge in the number of truck trailers completed about two years ago, because restrictive new standards were introduced by the Federal Government and many operators hurried to acquire equipment under the old standards that could be operated under grandfather clauses. New truck trailer construction then dropped off sharply but has regained a more usual level at the present time. The future looks reasonably optimistic for truck trailer uses of structural panels.

The recreational vehicle industry suffered a slump in 1974-75 and again in 1979 due to expectations that fuel would be difficult and expensive to get. Not all RV's are equally affected, but the larger vehicles other than campers have suffered a sharp drop in sales.

The material handling section of the industrial market has been steadily growing for a number of years, e.g. wood pallet production grew from 23 million in 1950

to 220 million units in 1978. The trend of the last two decades to replace manual material handling with automated handling systems will continue. This market offers sound growth potential for structural panel materials.

B. Furniture, Fixtures and Cabinetry

The major center for household furniture is in North Carolina and other parts of the South, but there are significant concentrations in the North Central states, and lesser ones in the Northeast and southern California.

Material use in this field is dominated by particleboards and medium density fiberboard, and thus the industry opportunity is discussed in the section dealing with particleboard. There is also considerable use of hardwood plywoods and solid lumber. There is some volume of structural panels, especially softwood plywood, for such parts as chair seats, store fixtures and dinette tops, and, consequently, some potential for waferboard.

Applications for Waferboard

Total consumption of structural particleboards in the United States in 1978 was about 355 million sq. ft., 3/8", including about 20 million sq. ft. of phenolic particleboard. The remainder was waferboard, of which the U.S. supplied about 80 million sq. ft. and the balance of about 255 million entered the United States from the several Canadian mills.

In 1978, consumption of waferboard was very heavy to the North Central U.S., which accounts for 78 percent of the total. The Northeast is next, using about 55 million sq. ft. The other sections of the United States, the South, Mountain, and Pacific states, are using only minimal quantities at the present time, primarily in the do-it-yourself market (Table 9).

1978 REGIONAL CONSUMPTION OF WAFERBOARDS

(Millions Sq. ft. 3/8")

New England	15
Mid-Atlantic	35
Total Northeast	50
East North Central	165
West North Central	95
Total North Central	260
South Atlantic	2
East South Central	3
West South Central	3
Total South	8
Mountain	2
Pacific	15
Total West	17
TOTAL U.S.	335

SOURCE: Leonard Guss Associates, Inc. estimates

I. Residential Construction

New construction markets obviously offer the major opportunity for structural particleboards. But, builders are always resistive to the adoption of new products since they bear the risk of product failure, and since they must change techniques or learn how to use new material. The restrictive effects of existing codes must also be overcome to allow waferboard to penetrate fully into the new construction market.

Much work has already been done on code acceptances, as most Canadian waferboards are now approved in 7/16" thicknesses for roof sheathing on residential structures, the largest immediate opportunity. In order to be accepted, of course, the product must be available at local levels, and priced favorably compared to softwood plywoods, that is, to 1/2" CDX for roof sheathing as mentioned earlier, while 3/8" plywood is code approved for roof application, most builders will not use 3/8" because of its flexing when used over usual spans. 7/16" waferboard does provide adequate stiffness, especially for 16" o.c. span.

Waferboards generally face only one serious technical obstacle to obtaining a much higher penetration in the roof sheathing market. Waferboard is slippery, particularly when wet. The usual process to reduce the slipperiness is by roughening or coating the surface; this has worked well. There are, of course, many builders who use the product on the basis of its cost advantage over softwood plywood, without regard to its slipperiness. Thickness swell is also considered a significant problem by builders.

Sidewall sheathing is a well accomplished market for waferboards in some parts of the country, but less so in the North Central states. Demands placed upon wall sheathing are much less than upon roof sheathing so that in applications where plywood is used, waferboard is a logical alternative. However, there are a large number of acceptable wall sheathings, many of which cost less than waferboards. The common competitive product is asphalt impregnated insulation board, which offers some degree of structural strength, plus insulation, plus nailability, at low cost. Another inexpensive wall sheathing is aluminized corrugated board. Recently, there has been increased interest in better insulation materials, especially small panels of foamed polystyrene. These have no structural strength and no nailability, but do contribute significantly to thermal insulation.

A major opportunity in new construction, still almost untapped, is in flooring systems although slab construction still accounts for substantial amounts of floor

space. On a surface measure basis, the market is larger in roofs; but floor systems generally utilize thicker components than roof sheathing, and hence the volume of plywood consumed in floor systems exceeds that for roof materials. Tongue and groove underlayment plywood, in both 5/8" and 3/4" are the primary products for single floor systems. CDX plywood is often used as a subfloor, over which an underlayment grade of urea particleboard is laid. Special grades of 2-4-1 plywood are used with joists widely spaced. So far only one manufacturer of waferboard has qualified his product in this use, but others are in process.

Structural waferboards also have some, but limited opportunity in the very large residential (cladding) siding market, for side walls, accents, and gable ends. The requirements are to be weather proof and to have attractive appearance characteristics, rather than for strength. Most claddings do not contribute to the structural integrity of a house, although there are certain uses of 5/8" plywood sidings applied without sheathing on 24" stud spacings, that are structural.

However, desirable siding appearances are based on tradition, and waferboards do not meet most peoples' traditional idea of what cladding should be. It will be difficult for waferboard to obtain major acceptance as cladding, although on the basis of price, it achieves a certain penetration, particularly for lower cost units; one possibility is the highly stylized use of panels in conjunction with battens for a Tudor look.

Currently, the use of uncoated structural waferboards as siding is small, but it should grow. Overlaid structural waferboards can be made to simulate traditional claddings and may be used in the future.

Other miscellaneous applications for waferboard exist in garage doors, interior panels, shelving, chimney enclosures, fences, balcony panels, and outdoor decks. The unique appearance of the product is a factor in such applications as fencing. The keys to greater usage of the product are availability and recommendations to builders by the retailer, rather than concern with codes, as is true for flooring and roofing.

Non-Residential Construction

The use of waferboards for roof deck will require engineering development, code approvals, and market promotion to architects and general contractors. The opportunity in commercial roof systems will remain relatively low over the next few years.

In concrete forming, certain coatings or overlays must be developed to make waferboard a successful candidate in the reusable form market. Such development is unlikely in the near future. However, the use of waferboards as a lower cost, one-time concrete form will increase in the next few years as the product becomes available.

Other non-residential construction uses include agricultural buildings, and auxiliary uses in shelters, barricades, shoring, and other miscellaneous facilitation material in non-residential construction. In these, the opportunities for wafer board look reasonably strong, and depend primarily upon the availability of the product at the distribution level, and trade promotion to the general contractor. No code or major breakthrough is needed to further the products into these market applications.

In agricultural buildings, particularly in animal housing and machinery sheds, several firms are now using waferboards in prefabricated structures. Panels larger than 4'x8' are advantageous in some of these applications.

Industrial Applications

Structural waferboard usage may increase modestly in **mobile home** construction. The best opportunity lies in replacing plywood roof sheathing for double wide units. Here waferboard may have an advantage in being capable of larger than 4'x8' panels. The heavier weight of the larger panels may, however, offset the efficiencies of their size.

Mobile home decking is, by far, the largest structural panel application in mobile homes; this will remain conventional urea particleboard unless regulations to

eliminate formaldehyde traces increase the cost significantly. Should this occur, it will enhance the opportunities for phenolic products, including conventional particleboard.

The **materials handling** market offers potential for structural particleboards. Pallets are a major factor in the materials handling market. Pallet manufacturers probably provide over half of the pallets used; the rest are made by firms for their own use. Perhaps 25 percent of the plywood now used for pallets could be obtained for waferboards. However, a sophisticated selling approach is often required, utilizing such technical data as stiffness and impact resistance, etc. Impact resistance must be demonstrated as satisfactory also to crating users and it is likely that plywood's superior impact resistance may be a deterrent to sales here. However, reliable testing and engineering data can reduce this handicap.

The **transportation industry** provides significant outlets for structural waferboards. In the truck market, there are three potential opportunities. Two of these relate to lining the inner walls of the truck and the third relates to the doors. Currently, two methods are used for the construction of truck sidewalls:

(1) Fiberglass reinforced plastic (FRP) over plywood is manufactured as a single piece up to a little over 8'x40'. Structural waferboards have not been adequate in strength to replace plywood in the core of these FRP single-wall units. However, additional R&D might enable waferboard to be used in single-wall panels.

(2) Plywood is used as lining, with an aluminum exterior. Here, the extra weight of waferboards compared to the AC plywood currently used is a disadvantage to the original equipment market. Still, substantial quantities of lining materials are used in the after-market (repair, alterations) and, for those carriers hauling lighter volumes of freight, the economy of the re-lining material can be more important than the modest weight increase.

Truck doors offer a good opportunity for structural waferboard. Here again the weight of the product will be a modest disadvantage, but the grade requirements for the plywood in truck doors are extremely high, and the material is very expensive. Structural particleboards can be used as a core material replacing plywoods at lower cost.

The best opportunity for waferboard within the transportation market lies in recreational vehicles, including travel trailers, vans and camping units. Here, structural waferboards, particularly larger than 4'x8' sizes, have already achieved significant penetration as single floors. The weight of structural particleboards, vis-a-vis softwood plywood, is a deterrent in some applications, particularly in the smaller units, where efforts are made to keep the total towing weight below a thousand pounds.

Railroad equipment is not likely to become a major market. The percentage of cars using lining of any type is declining; most lining that is done is for insulated refrigerator cars that require food grade liners. Waferboard could be a core material, under a surface that can get a sanitary lining approval. Generally, the manufacturers of refrigerated cars buy the sanitary lining materials from firms who specialize in these products; not all of them use a structural material as a core, but there are opportunities here.

In all cases, it will be necessary to conduct a technical selling effort to transportation equipment users and manufacturers on the adequacy of the product to meet the needs. The primary competition will remain softwood plywoods. Given a proper technical selling effort, structural waferboards could obtain 20 to 30 percent of the plywood currently used.

There is a wide array of other products made for sale, including furniture, fixtures, signs, displays, and sporting goods. Customers may cut up their own panels, or utilize the services of fabricating companies who cut particleboards, hardboard, and plywood to the final size and ship them on to the manufacturer who then assembles. Softwood plywoods are used to a modest degree in this

application, but hardwood plywoods dominate. The opportunities for the structural waferboards are limited, however; there are only a few applications which require the strength of structural waferboards over conventional particleboards. Upholstered furniture parts, commercial fixtures, and chair seat bottoms, are examples where the structural waferboards can be justified. There are also materials purchased for factory repair and maintenance with the work done by plant personnel. Shelving, flooring, decks, storage areas, barricades, enclosures, safety devices, are some of the applications in which structural particleboards can be utilized for in-plant repair and construction.

Consumer Repair and Remodeling

Consumer repair, remodeling, and additions is one of the larger U.S. markets for waferboards. The product flows to market via distributors and retailers, and is sold for paneling and for all types of remodeling and construction purposes.

In additions and alterations, when a contractor is utilized by the home owner, the contractor will ordinarily use the same type of materials that are used in new construction. However, the home owner, when undertaking a project himself, will often find (if structural waferboards are visibly available at the dealers) that waferboards may well work in lieu of plywoods. Currently, there are about 4.8 billion sq. ft. 3/8" of plywood consumed in the after-market. The continuing growth of the repair and remodeling market will assist the growth of structural waferboards as well.

CHANNELS OF DISTRIBUTION

The wood products industry is highly fragmented and often its end markets are geographically far removed from the major producing areas. Thus, the industry must rely on a complex system of channel intermediaries, including several types of wholesalers, agents, dealers, dealer-builders, and manufacturer-owned distribution outlets.

Starting in the 1950's and continuing through today, there have been a number of significant changes taking place in the distribution of wood products, including structural panels.

The growth of large merchant builder-developers has forced changes in the distribution system. These firms are considerably less dependent on local dealers than are custom builders, and they are more conscious of material costs. In a number of cases, large builders have established (or purchased) merchant wholesalers of their own, in a form of vertical integration. This has permitted them to buy at mill prices.

The growth of industrialized housing and mobile home manufacturers has created a need for new types of pre-cut, pre-fabricated and made-to-order materials. Most such customers buy mill direct, or mill via an office wholesaler.

The growth of the do-it-yourself repair and remodeling segment of the market has given impetus to large one-stop home repair centers. Convenience-oriented broad line suppliers moved in to satisfy this market and filled their inventories and showrooms with plumbing, hardware, and other non-wood items, in addition to lumber, plywood, paneling, and millwork.

The trend to larger producing units increased pressure to achieve greater sales volume at the mill level. One means of doing this was to encourage the development of multi-yard dealers and builder-dealers with central purchasing offices. The decline of small mills also hastened the demise of many office wholesale organizations and commission sales agencies, whose function of matching fragmented supply and fragmented demand is gradually becoming less relevant.

Improvements in transportation and communication have expanded the geographic areas which can be served by wholesalers and/or the mills themselves. Conversely, the sharp increases in transportation costs act to restrict the sales area for commodities.

Finally, there had been an increasing emphasis in the wood products industry on **cost efficiency and the use of a "systems" approach** to distribution. The traditional methods of distribution, sometimes called the "three step" channel, meant that softwood plywood, for example, was physically handled (with consequent labor, equipment, and damage costs) several times on its way to the end user. This both inflated the retail price of the product and removed much of its control from the manufacturer. In commodities, it is essential that prices be kept competitive and (for the larger producers) that wood products manufacturers maintain an "image" which is part of their marketing approach.

Evolving Distribution Patterns

During the last decade or so, the channels of distribution have become shorter and more specialized. By and large, the merchant wholesaler firms which have survived are of two types: (1) the multi-line firms which have very large inventory areas and handle broad categories of goods for the mass merchandisers, and (2) the wholesalers who have moved in the other direction toward specialization in one or a very few types of materials (e.g., sash and doors, plywood, siding, paneling). The latter typically operate in large urban areas which can develop a high volume of demand for their limited product lines. Both types of wholesalers will generally sell to large builders and mass merchandisers, as well as to traditional retail yards and industrial accounts. There has also been an increased participation on the part of manufacturers in establishing captive wholesale outlets, selling their own production and that of other manufacturers.

At the retail level there have been several changes, brought about by increasing segmentation in the building materials end-markets. There are now four general categories of dealers, instead of the formerly ubiquitous "lumber yard."

(1) **mass merchandisers** or cash-and-carry dealers carry a wide line of products, stay open longer hours, and rely on fast turnover and self service.

(2) **construction supply dealers** who carry large stocks of bulky materials (lumber, plywood, reconstituted panels, wallboards, insulation) and sell them at low margin prices to high volume builders and contractors. These firms are usually able to buy directly from the producers and are increasingly becoming involved in secondary manufacture (e.g. roof trusses, wall panels, etc.)

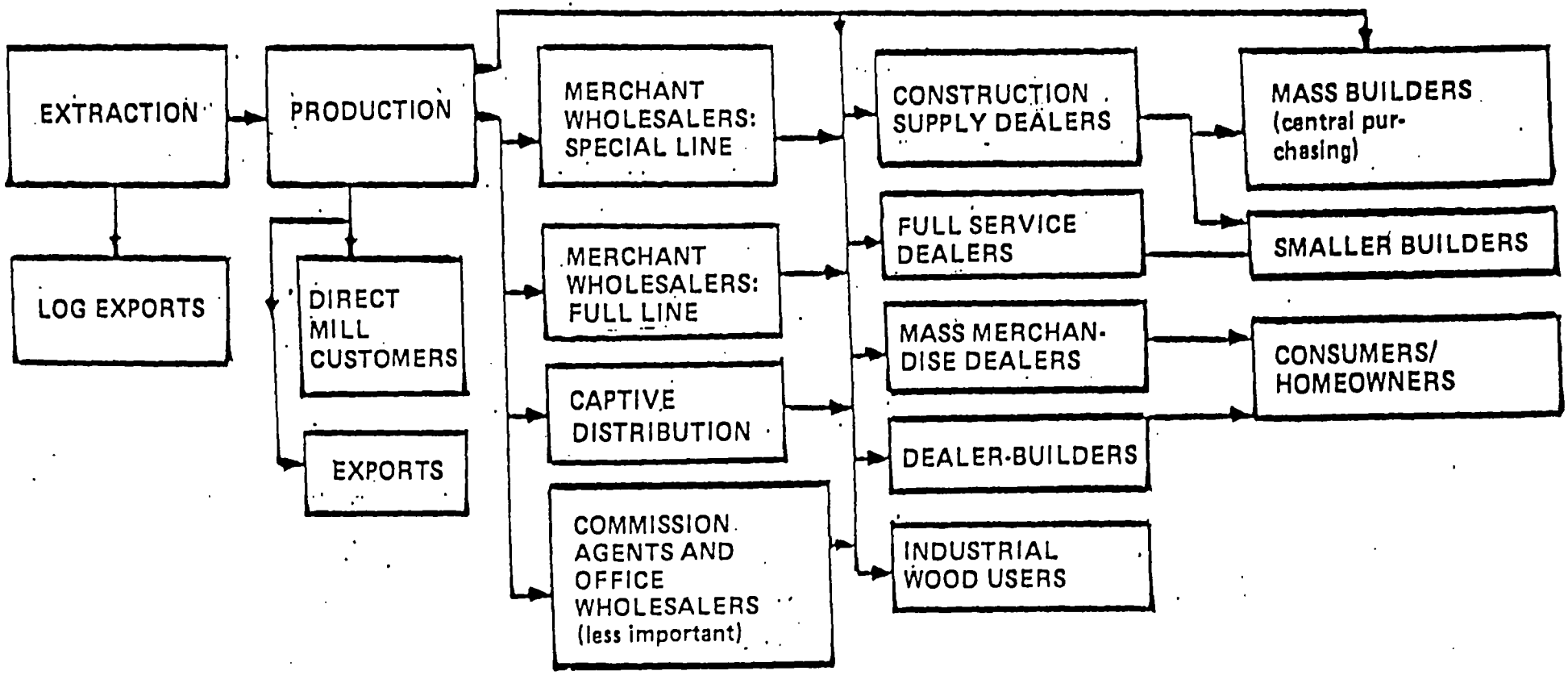
(3) **full-service dealers** who perform a range of services including design, cost estimating, financing, and planning assistance for smaller building firms. These firms, in order to face the more stringent competition of the market, have upgraded their service capabilities, and most have expanded their lines to include appliances and kitchen cabinets.

(4) **dealer-builders,** who sell the materials and the labor to put them together. These firms engage in home construction, remodeling, garage additions, and/or other aspects of the building trade.

Figure 3 illustrates those channels which are now operative in the distribution of wood products. Waferboards are now and in the future will continue to fit into the ongoing system. Any producing mill will utilize at least two and probably more of the available distribution channels.

Figure 3

CURRENT DISTRIBUTION PATTERNS FOR WOOD PRODUCTS FIRMS



PRICING

Since waferboard prices have historically been related to softwood plywood prices, a discussion of the latter is appropriate. Over the years the producers of structural reconstituted waferboards have attempted to hold their prices about 10-15 percent below those of competitive plywoods. No exact relationship was or is possible because the prices of softwood plywoods fluctuate rapidly, more rapidly than waferboards could follow. Also, there is no one "plywood" with which waferboards compete, but rather a grouping of such plywoods, that is, 3/8" or 1/2" thick, 3, 4, or 5 layer, of southern or western species, with different glue lines or qualities of face veneer, etc. At best, then, waferboards have been 10-15 percent below the average price of a mix of softwood plywoods, for most of the time.

Plywood

Plywood has consistently maintained a close approximation to the classic definition of a commodity product. There are many buyers, many sellers, and the price fluctuates daily, sometimes hourly, in response to supply and demand, as each buyer and each seller continuously searches out a mutually satisfactory transaction price. The seller will sell based on his own inventory and order file position, and his anticipations for the future in terms of demand and alternative supply. His actual costs of production have little to do with the sale price except, when the obtainable price gets too low, it sets a floor below which he cannot operate. The buyer takes into account his perceptions of demand and supply, his expectations for the future, including such factors as possible transportation tie-ups, forest fires, strikes, and the like. Dealing with a commodity, he is reasonably indifferent as to supplier, except that, at an equal price or at best a dollar or two more, he favors certain suppliers of good reputation.

Figure 4 shows Random Lengths' five year price history of 1/2" Standard CDX Douglas Fir, FOB. The traditional discount schedule of five and three percent has not been deducted. Prices have ranged from lows of $107 in 1972-74, to a high of $249 in November, 1978.

Figure 4 — 1/2", Standard Exterior (4/5 Ply)

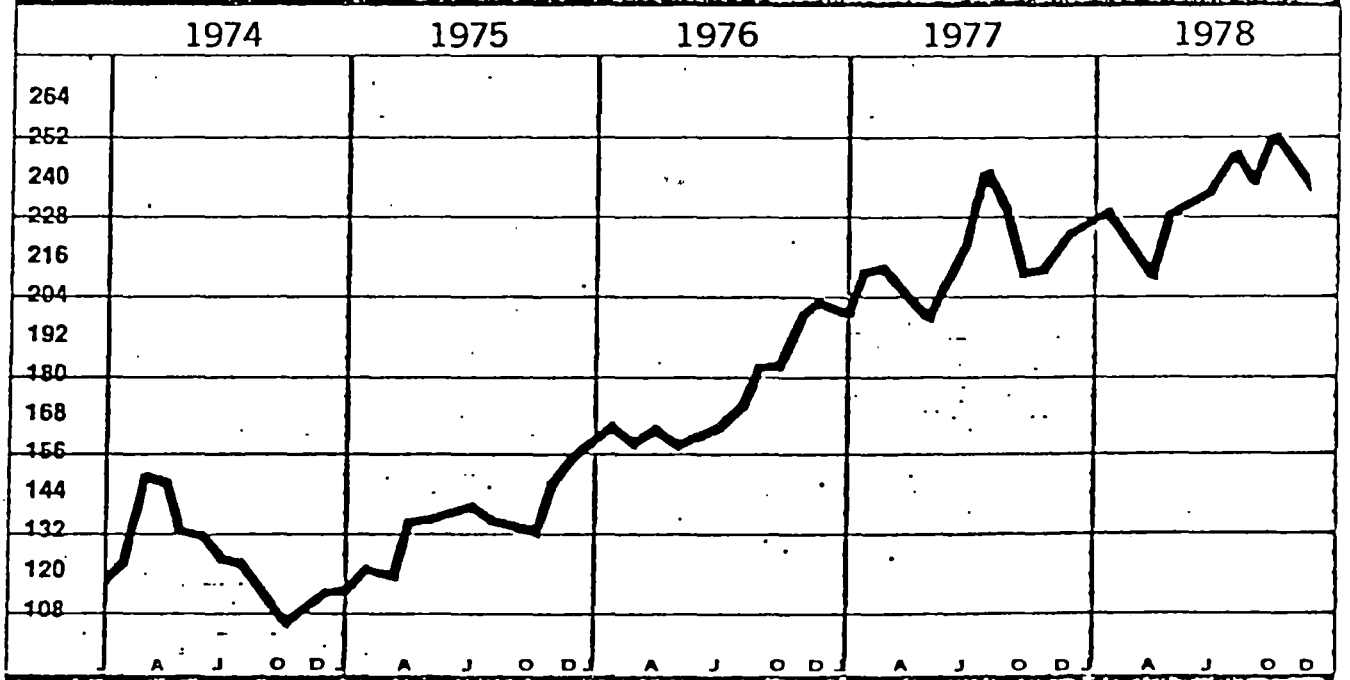
Price History of Douglas Fir Plywood

(Prices f.o.b. Mill, Less 5% & 3%)

Monthly Averages of Reported Prices

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1968	75	81	80	83	83	94	98	107	120	120	120	133
1969	134	139	129	92	91	81	81	83	82	83	80	78
1970	75	76	75	78	78	83	85	89	87	82	76	77
1971	81	91	91	87	84	89	101	101	96	90	95	98
1972	107	110	111	111	118	136	156	156	156	156	156	156
1973	163	184	179	170	144	133	119	117	107	107	137	116
1974	120	125	151	149	133	132	126	125	116	107	109	115
1975	116	123	121	137	137	138	141	136	135	133	147	156
1976	161	166	161	165	160	163	165	172	185	185	199	204
1977	201	214	215	207	201	209	220	243	233	212	213	227
1978	228	231	221	213	229	233	237	246	241	253	249	240

Five-Year Trends



Five-Year Monthly Averages

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1970-74	109	117	121	119	111	115	117	118	112	108	115	130
1971-75	117	127	131	131	123	126	129	127	123	119	129	128
1972-76	133	142	145	146	138	140	141	141	140	138	150	149
1973-77	152	162	165	166	155	155	154	159	155	149	161	163
1974-78	165	172	174	175	172	175	178	184	182	178	183	188

SOURCE: RANDOM LENGTHS

Figure 5 is a similar graph for 1/2" Standard Exterior Southern pine, on a net selling price basis. Typically southern pine plywood mills obtain about $15 more than Douglas fir equivalents due to their freight advantage in selected major markets. Prices prior to June, 1977 on this graph are not comparable to the data in Figure 4 since they were established on a different basis.

So far in 1979, plywood prices have softened in response to slackened building and competition from structural particleboards.

Waferboard

The dominance of softwood plywood in controlling waferboard prices will continue for the five year future, at least, and likely there will be interaction between the two product classes indefinitely.

Leonard Guss Associates, Inc. believes that the "floor" price for softwood plywood, the point at which some production will cease, will be higher in the future than in the past, except for temporary and spot situations, because of a number of changing factors: increased pressure on the wood supply; increasing concentration in the industry, the diminishing of cooperatively owned plywood plants which keep operating to save jobs rather than for profit; and inflationary increase in certain operating costs in real terms. However, these should be offset to a certain extent by continued improvements in operating economies, especially in the newest plants, and as the older plants withdraw from production. The net effect should be to force a rising price trend over the next two decades.

Leonard Guss Associates, Inc. has obtained some price data from one Canadian waferboard plant which represents some of the price changes of the 1975-79 period. See Table 10.

The mill realization for waferboards will depend on the mill location, since it will receive a price comparable to that of softwood plywood sheathing delivered to a major market, less a differential of 10-15 percent, less freight to that major market.

Figure 5

1/2", Standard Exterior (4/5 Ply)

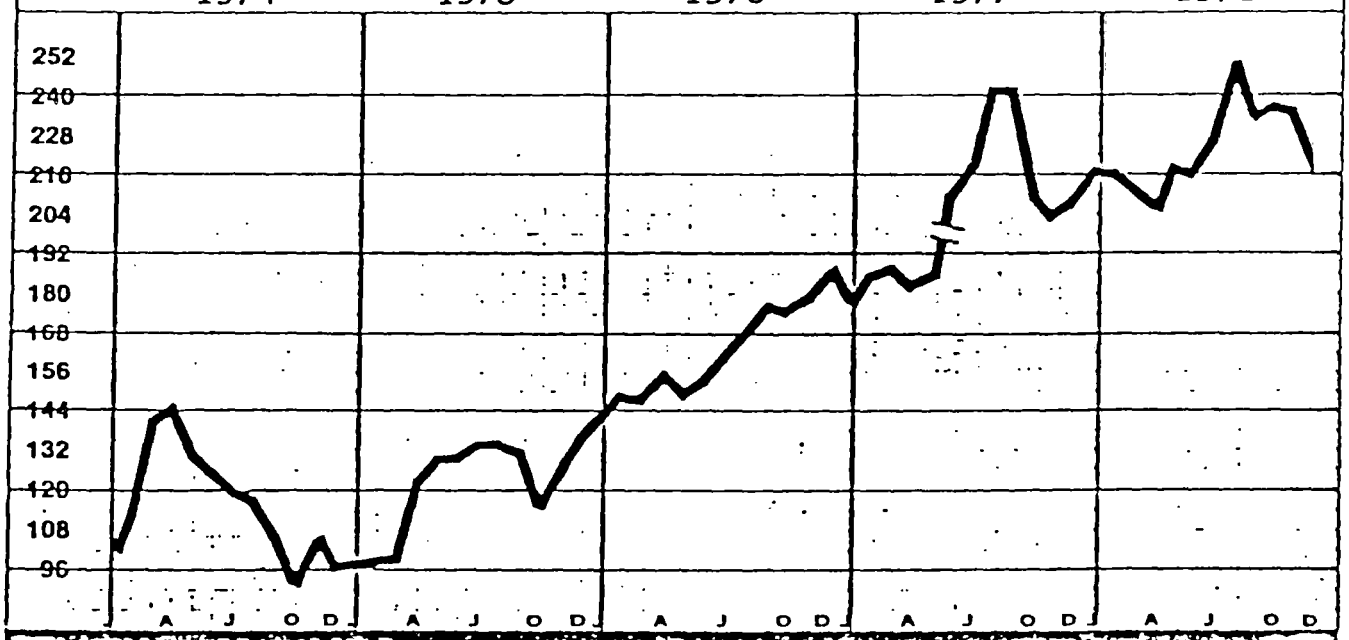
Price History of Southern Pine Plywood

(Prices Net f.o.b. Mill)

Monthly Averages of Reported Prices

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1968	71	75	78	78	80	89	95	99	118	120	118	127
1969	124	128	118	93	88	75	73	79	79	79	78	71
1970	66	66	67	74	75	77	83	89	87	78	72	72
1971	77	88	85	80	80	87	96	101	96	87	90	91
1972	102	104	105	106	112	124	141	142	142	142	142	142
1973	146	151	155	155	145	131	106	108	95	93	133	111
1974	105	114	142	145	131	125	120	118	107	93	105	96
1975	97	100	101	122	130	131	135	136	132	117	126	137
1976	144	149	148	156	150	155	161	171	177	175	180	186
1977	180	187	189	183	187	211*	219	243	242	212	204	211
1978	217	217	212	209	220	218	227	249	235	238	237	221

Five-Year Trends



Five-Year Monthly Averages

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1970-74	99	105	111	112	109	109	109	112	105	99	108	102
1971-75	105	111	118	122	120	120	120	121	114	106	119	115
1972-76	119	124	130	137	134	133	133	135	131	124	137	134
1973-77	134	140	147	152	148	--	--	--	--	--	--	--
1974-78	--	--	--	--	--	--	--	--	--	--	--	--

SOURCE: RANDOM LENGTHS

Table 10

WAFERBOARD PRICES, KEY ITEMS, FOB MILL (NORTHERN ONTARIO)

(U.S. Dollars, Less Freight, Duty, and Trade Discount)

	7/16" Roughened Sheathing	3/8"	1/4"
March, 1975	$ 115.45	$ 95.02	$ 73.61
July, 1975	124.39	105.62	81.70
October, 1975	133.92	114.06	88.24
March, 1976	140.35	119.76	92.65
June, 1976	134.32	114.06	88.24
March, 1977	144.10	119.76	92.65
August, 1977	160.80	125.75	97.28
September, 1977	181.14	142.60	110.32
January, 1978	175.50	142.60	110.32
May, 1978	164.50	142.60	110.32
July, 1978	164.50	142.60	110.32
August, 1978	182.50	149.00	115.00
September, 1978	176.50	149.00	115.00
October, 1978	176.00	149.00	115.00
January 29, 1979	165.00	153.00	110.00
March 5, 1979	170.00	153.00	110.00
October 5, 1979	175.00	158.00	115.00

REQUIREMENTS FOR COMPETITIVE MARKETING OF WAFERBOARDS FROM DEAD SOFTWOODS

The requirements for marketing waferboards from dead softwoods are unlikely to differ from those applicable to any structural reconstituted panel. Previous technical research has established that there are no significant perceived differences between some structural flakeboards from dead versus green softwoods. The differences that do exist are not reflected in product characteristics that are meaningful to the market.

> "There is an excellent technical potential to utilize ponderosa pine for making composite panel products. Ponderosa pine wood and fiber is particularly well suited for products of these kinds. Particleboard utilizing ponderosa pine is manufactured and widely marketed in the western region of the United States.
>
> Studies by Barger, et.al. and Markstrom et.al. that evaluated production of particleboard with UF and PF resins from ponderosa pine roundwood, as well as sawmill and forest residues, have indicated very favorable results. **Recently, laboratory work to evaluate composition board from dead white pine and lodgepole pine revealed that furnish from standing dead trees of these species showed little difference from that of live trees.** A problem with the internal bond characteristics of structural flakeboard made from this material was attributed to poor flake surface quality, which probably results from flaking dry wood normally associated with dead timber. Linear expansion was reported to be relatively higher on boards made from both live and dead lodgepole pine. Lehmann and Geimer working with Douglas fir forest residues for structural particleboard stated that panels containing sound (sic) dead wood with incipient decay suffered little or no loss in either strength or dimensional stability properties when compared to the control panels made from live wood. It was found that only when badly decayed wood was added to the raw material was the quality of the board seriously affected.
>
> In this study, no exhaustive effort went into the technical feasibility of manufacturing particleboard from standing dead ponderosa pine wood, but it seems apparent that suitable furnish can be made from beetle-killed ponderosa pine."*

*Troxell et.al., op.cit. in Appendix A.

In order to achieve the goal of selling a waferboard product from any new plant, there are certain requisites:

... a well manufactured product, with properties equal to any competitive waferboard
... priced at from 10-15 percent below the prevailing price for 1/2" CDX 3-ply sheathing, delivered basis
... approved by BOCA, ICBO, and other relevant state and trade regulatory agencies for multiple uses
... agency stamped
... supported by a modest but well-planned promotional effort

Quality

All waferboards are not quite alike, despite similarities in appearance properties.

Evidence of good manufacturing standards should be apparent:

(1) panels square cut to close tolerances
(2) surfaces roughened properly for roof sheathing
(3) sanding, where appropriate, that does not tear the surface
(4) packs should be double steel strapped in units of standard size (60 panels for 7/16")
(5) half units should be available
(6) well marked with grade information

A plant must be capable at least of producing any thickness from 1/4" through 3/4", 4' wide. As approvals are obtained for waferboard floor support systems, a large market will develop for 5/8" and 3/4" panels.

Length for all standard applications is fixed at 8'. Only rarely is the need for longer length panels appreciated. One exception is the mobile home industry. If waferboard, with or without a smoothed surface (sanding, application of fines, overlay, etc.) is used as mobile home deck, lengths of 12' and 16' are required.

The product line could include some 4'x4' and 2'x4' unit packs developed for the retail trade. Some dealers have had considerable success with these sizes.

Other products could include T-111, channel grooved and board and batten siding products although markets have not yet been established for them. Such a market may not materialize unless the product can be overlayed to simulate the appearance of lumber or plywood. Siding products must include 9' and preferably 10' panels as well.

Code Approvals

As reitereated in the report, code approvals are an absolute must for volume sales of waferboard. The controlling codes are BOCA (Building Officials and Code Administrators, International), located in Chicago, ICBO (International Conference Building Officials) located in Pasadena, and SBC (Southern Building Code) located in Atlanta. Figure 6 shows where each code holds sway.

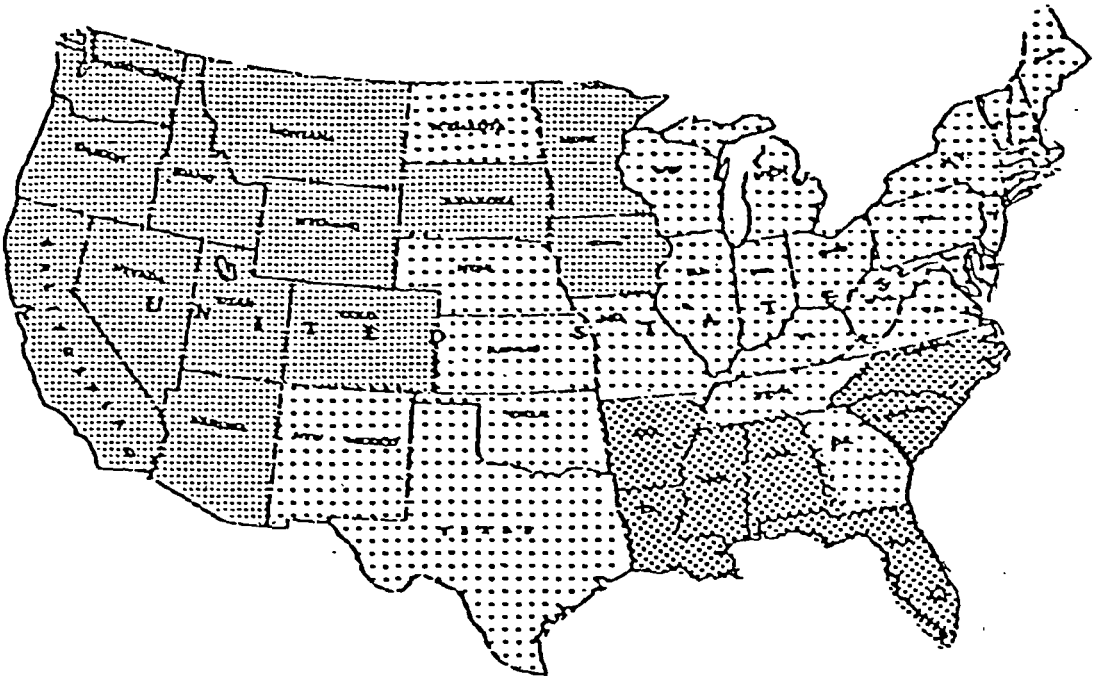
Selling and Marketing Support

A new plant would require a modest size, effective mill sales force. Market support requires the creation of an effective informational brochure, describing the product, its properties, its code approvals, restrictions on use, and methods of application. Participation in regional builder and dealer shows, at least initially, may also be desireable although, by the year 2,000 or so, will no longer be necessary.

Samples are a must, and should be attractively prepared, perhaps in a sample kit.

While some limited trade advertising may be useful at first, general consumer advertising or widespread trade advertising is not indicated.

FIGURE 6 BUILDING CODE USAGE



I.C.B.O.

S.B.C.

B.O.C.A.

I.C.B.O. (International Conference Building Officials)
B.O.C.A. (Building Officials and Code Administration, Inc.)
S.B.C. (Southern Building Code)

ADVANTAGES AND DISADVANTAGES OF PRODUCTION IN THE INLAND REGION

An analysis of the material presented in the preceding sections indicates clearly that structural particleboards in general, and waferboard in particular, are products whose time has come. Waferboard has undergone a long induction period, one of slow growth, testing, and market development. That period, which lasted from 1964 through 1977 is now over. Waferboard has had a fair trial and has succeeded handsomely.

As a result, the five Canadian and one U.S. waferboard plants that were operating at the beginning of 1979 will be joined within two to three years by anywhere from 16 to 20 other plants, including composite panel and oriented flake types, depending on the firmness of the decisions made to build them.

By the time that any new plant placed in the northern portion of the dead softwood region could be operative (say, 1982 at the earliest) the market in the primary accessible region (Washington, Oregon, Idaho, Montana, Wyoming, North Dakota, South Dakota, Nebraska) should approximate 400 million sq. ft. 3/8". This calculation is based on a potential of a fifth of the structural panel market which, in that year, could comprise 1.75 billion 3/8" sq. ft. of sheathing grade plywoods and 0.25 billion sq. ft. 3/8" of markets now supplied by particleboards or not now supplied at all, that is, demand, mostly at the consumer level, that will be created **because of** the properties and availability of waferboards locally.

LGA estimates a maximum of a fifth of this market as potentially available to waferboards in view of the strong western and inland region production of sheathing grade plywoods the combined output of which, in 1978, amounted to 4.6 billion sq. ft. 3/8". This is comparable to the share of market obtained by waferboards in other regions (such as eastern Canada) where plywood is produced.

The market in both the primary region, and in the accessible secondary region, here defined as all states west of the Mississippi, could approximate 1.4 billion sq. ft. 3/8" calculated the same way. That is, the total market for structural panels in that broad region by 1982 could reach 7 billion sq. ft. 3/8" including

sheathing grade plywoods, particleboards and new demand, of which total about a fifth could be available to waferboards.

To supply this demand there should be by that time six plants in place in the U.S., most on the eastern fringe of the Inland region and all except one west of the Mississippi. Total announced capacity is 830 million sq. ft. 3/8" for these six plants.

Another seven Canadian plants, in operation or announced, with a capacity of about 600 million sq. ft. 3/8" will be located so that they can serve all or parts of the region at least fairly well. Canadian supply should remain a factor in the future as in the past despite current tariff levels, which are due to decline, and possible changes in the now very favorable ratio of the Canadian to the U.S. dollar. Thus, it is no longer possible to say, as it was a couple of years ago, that likely demand far exceeds foreseeable supply. Rather, if one new plant is built in the dead softwood region, available supply would match or even just exceed projected demand.

Such a new plant would have one advantage over existing and announced structural flakeboard facilities: it is the furthest west of any plant (except Alberta Aspen) and thus is in a better position to serve the Mountain states and parts of the Southwest and Plains states as well.

While the impact of inflation in terms of rising wage, power, resin, logging, and other costs will continuously raise costs for both softwood plywood and waferboard, they should affect plywood more. Inflation will also raise the cost of transportation, so that the advantages accruing to waferboard of being closer to markets than plywood will widen.

Moreover, although new plywood plants are going up in the South, old ones (mostly sanded but some sheathing) have closed in the West, and a number of other, older plywood plants in the West, especially those dependent on public timber, will close over the next decade. The potential supply of softwood plywood will thus be reduced.

Freight

In the marketing of commodity products which are otherwise broadly substitutable freight charges are always a major factor and often the deciding one. Freight is paid by the buyer and is an add-on to the net mill price he pays. A plant located in the dead softwood areas would have a relatively restricted region of freight advantage. Clearly, such a plant would have freight advantages over plywood produced on the west coast, to almost all feasible markets except for southern California, where the freight costs for west coast sheathing, inland sheathing or plywood made in California, are likely to be about the same or lower.

The advantages decline rapidly in midwestern and eastern markets. In Chicago, for example,the most advantageous sources in terms of freight would be from plants located in or near Rapid City, South Dakota, or Denver, Colorado; currently such charges are about $25/000 sq.ft. 3/8" by rail; (Tables 11-22 provide detailed freight comparisons). However, plywood from these same locations would deliver for up to $4 less because of its lighter weight.

Even more favorable are the applicable rates for plywood from the South. Such plywood delivers to Chicago for little more than $18/000 sq. ft. 3/8" and serves the same purposes (Table 23). Thus, LGA deems Chicago to be at the fringe of the effective trading area for dead softwood reconstituted panels if not, in fact, a little beyond it.

A substantial percentage of material moves by truck and would also travel by truck from a dead softwood region plant. Truck rates are generally a few dollars more than rail, but generally in the same proportion and relationships as rail. Truck shipments are convenient for firms requiring smaller volumes who still wish to buy mill direct or firms not on a rail siding; the latter is true of an increasing number of firms today. Table 24 shows comparative truck rates from one dead softwood region possible location compared to a location which is now shipping waferboards to market.

However, it is unrealistic to restrict waferboard potential solely to those geographic regions where it has a freight advantage. This ignores the fact that waferboard now sells in areas where it is at freight par or even a disadvantage, because of its unique properties, or the willingness of producers to absorb some costs. Still, such freight comparisons do indicate the broad market limits for the product.

Using the information developed in the freight tables for a potential waferboard plant in the dead softwood region, LGA elects to use $25 per M sq. ft. 3/8" as the average maximum allowable freight to market.

Table 11

CARLOAD RATES APPLYING ON PLYWOOOD

From Chester, California

effective 10/15/79

TO:	Carload Rates in cents per 100 Pounds (CWT)			Carload Rates in $/M Sq. Ft. 3/8"
Chicago, IL	327 85,000#	300 (A)	289 (B)	36.79
Houston, TX	296 85,000#	267 (A)	258 (B)	33.30
Jasper, IN	381 85,000#	331 Excess	-	42.86
Kansas City, MO	296 85,000#	267 (A)	258 (B)	33.30
Los Angeles, CA	109 85,000#	89 Excess	-	12.26
Minneapolis, MN	313 85,000#	285 (A)	274 (B)	35.21
Winston-Salem, NC	389 70,000#	-	-	43.76

(A) Applies on excess weight on shipments not exceeding 119,999#

(B) Applies on excess weight on shipments weighing 120,000# or more

Table 12
CARLOAD RATES APPLYING ON PLYWOOD

From La Grande, Oregon

effective 10/15/79

TO:	Carload Rates in cents per 100 Pounds (CWT)			Carload Rates in $/M Sq. Ft. 3/8"
Chicago, IL	327 / 85,000#	300 (A)	289 (B)	36.79
Houston, TX	322 / 85,000#	293 (A)	285 (B)	36.22
Jasper, IN	380 / 95,000#	330 Excess	-	42.75
Kansas City, MO	296 / 85,000#	267 (A)	258 (B)	33.30
Los Angeles, CA	146 / 85,000#	113 Excess	-	16.43
Minneapolis, MN	296 / 85,000#	267 (A)	258 (B)	33.30
Winston-Salem, NC	389 / 70,000#	-	-	43.76

(A) Applies on excess weight on shipments not exceeding 119,999#

(B) Applies on excess weight on shipments weighing 120,000# or more

Table 13

CARLOAD RATES APPLYING ON PLYWOOD

From Boise, Idaho

effective 10/15/79

TO:	Carload rates in cents per 100 Pounds (CWT)			Carload rates in $/M Sq. Ft. 3/8"
Chicago, IL	323 85,000#	294 (A)	286 (B)	36.34
Houston, TX	322 85,000#	293 (A)	285 (B)	38.23
Jasper, IN	373 85,000#	323 Excess	-	41.96
Kansas City, MO	291 85,000	262 (A)	251 (B)	32.74
Los Angeles, CA	166 85,000#	136 Excess	-	18.68
Minneapolis, MN	291 85,000#	262 (A)	251 (B)	32.74
Winston-Salem, NC	389 70,000	-	-	43.76

(A) Applies on excess weight on shipments not exceeding 119,999#

(B) Applies on excess weight on shipments weighing 120,000# or more

Table 14

CARLOAD RATES APPLYING ON PLYWOOD

From Missoula, Montana

effective 10/15/79

TO:	Carload Rates in cents per 100 Pounds (CWT)			Carload Rates in $/M Sq. Ft. 3/8"
Chicago, IL	323 / 85,000#	294 (A)	286 (B)	36.34
Houston, TX	322 / 85,000#	293 (A)	285 (B)	36.23
Jasper, IN	363 / 95,000#	313 Excess	-	40.75
Kansas City, MO	291 / 85,000#	262 (A)	251 (B)	32.74
Los Angeles, CA	232 / 85,000#	199 Excess	-	26.10
Minneapolis, MN	291 / 85,000#	262 (A)	251 (B)	32.74
Winston-Salem, NC	389 / 70,000#	-	-	43.76

(A) Applies on excess weight on shipments not exceeding 119,999#

(B) Applies on excess weight on shipments weighing 120,000# or more

Table 15

CARLOAD RATES APPLYING ON PLYWOOD

From Denver, Colorado

effective 10/15/79

TO:	Carload Rates in cents per 100 Pounds (CWT)	Carload Rates in $/M Sq. Ft. 3/8"
Chicago, IL	196 / 70,000#	22.05
Houston, TX	243 / 60,000# 151 Excess	27.34
Jasper, IN	356 / 36,000#	40.05
Kansas City, MO	135 / 70,000#	15.19
Los Angeles, CA	355 / 50,000#	40.04
Minneapolis, MN	184 / 70,000#	20.70
Winston-Salem, NC	291 / 50,000# 193 Excess	32.74

Table 16

CARLOAD RATES APPLYING ON PLYWOOD

From Rapid City, South Dakota

effective 10/15/79

TO:	Carload Rates in cents per 100 Pounds (CWT)	Carload Rates in $/M Sq. Ft. 3/8"
Chicago, IL	186 / 70,000#	20.93
Houston, TX	288 / 60,000# 187 Excess	32.40
Jasper, IN	356 / 36,000#	40.05
Kansas City, MO	162 / 70,000#	18.23
Los Angeles, CA	355 / 50,000#	39.94
Minneapolis, MN	129 / 70,000#	14.51
Winston-Salem, NC	285 / 50,000# 182 Excess	32.06

Table 17

CARLOAD RATES APPLYING ON PARTICLEBOARD

From Chester, California

effective 10/15/79

TO:	Carload Rates in cents per 100 Pounds (CWT)			Carload Rates in $/M Sq. Ft. 3/8"
Chicago, IL	327 / 85,000#	299 (A)	290 (B)	42.92
Houston, TX	297 / 85,000#	267 (A)	258 (B)	38.98
Jasper, IN	363 / 140,000#	-	-	47.55
Kansas City, MO	297 / 85,000#	267 (A)	258 (B)	38.98
Los Angeles, CA	109 / 85,000#	89 Excess	-	14.30
Minneapolis, MN	314 / 85,000#	284 (A)	274 (B)	41.21
Winston-Salem, NC	388 / 70,000#	-	-	50.93

(A) Applies on excess weight on shipments not exceeding 119,999#

(B) Applies on excess weight on shipments weighing 120,000# or more

Table 18

CARLOAD RATES APPLYING ON PARTICLEBOARD

From LaGrande, Oregon

effective 10/15/79

TO:	Carload Rates in cents per 100 Pounds (CWT)			Carload Rates in $/M Sq. Ft. 3/8"
Chicago, IL	327 85,000#	299 (A)	290 (B)	42.92
Houston, TX	322 85,000#	293 (A)	284 (B)	42.26
Jasper, IN	373 85,000#	307 Excess	-	48.96
Kansas City, MO	297 85,000	267 (A)	258 (B)	38.98
Los Angeles, CA	145 85,000#	125 Excess	-	19.03
Minneapolis, MN	297 85,000#	267 (A)	258 (B)	38.98
Winston-Salem, NC	388 70,000#	-	-	50.93

(A) Applies on excess weight on shipments not exceeding 119,999#

(B) Applies on excess weight or shipments weighing 120,000# or more

Table 19

CARLOAD RATES APPLYING ON PARTICLEBOARD

From Boise, Idaho

effective 10/15/79

TO:	Carload Rates in cents per 100 Pounds (CWT)			Carload Rates in $/M Sq. Ft. 3/8"
Chicago, IL	323 / 85,000#	294 (A)	285 (B)	42.39
Houston, TX	322 / 85,000#	293 (A)	284 (B)	42.26
Jasper, IN	368 / 85,000	299 Excess	-	48.30
Kansas City, MO	291 / 85,000#	262 (A)	251 (B)	38.19
Los Angeles, CA	166 / 85,000#	137 Excess	-	21.79
Minneapolis, MN	291 / 85,000#	262 (A)	251 (B)	38.19
Winston-Salem, NC	388 / 70,000#	-	-	50.93

(A) Applies on excess weight on shipments not exceeding 119,999#

(B) Applies on excess weight on shipments weighing 120,000# or more

Table 20

CARLOAD RATES APPLYING ON PARTICLEBOARD

From Missoula, Montana

effective 10/15/79

TO:	Carload Rates in cents per 100 Pounds (CWT)			Carload Rates in $/M Sq. Ft. 3/8"
Chicago, IL	323 / 85,000#	294 (A)	285 (B)	42.39
Houston, TX	322 / 85,000#	293 (A)	284 (B)	42.26
Jasper, IN	355 / 85,000#	290 Excess	-	46.59
Kansas City, MO	291 / 85,000#	262 (A)	251 (B)	38.19
Los Angeles, CA	206 / 125,000#	-	-	27.04
Minneapolis, MN	291 / 85,000#	262 (A)	251 (B)	38.19
Winston-Salem, NC	388 / 70,000#	-	-	50.93

(A) Applies on excess weight or shipments not exceeding 119,999#

(B) Applies on excess weight on shipments weighing 120,000# or more

Table 21

CARLOAD RATES APPLYING ON PARTICLEBOARD

From Denver, Colorado

effective 10/15/79

TO:	Carload Rates in cents per 100 Pounds (CWT)		Carload Rates in $/M Sq. Ft. 3/8"
Chicago, IL	196 / 70,000#		25.73
Houston, TX	243 / 60,000#	151 / Excess	31.89
Jasper, IN	340 / 40,000#		44.63
Kansas City, MO	135 / 70,000#		17.72
Los Angeles, CA	322 / 75,000#		42.26
Minneapolis, MN	184 / 70,000#		24.15
Winston-Salem, NC	292 / 50,000#	192 / Excess	38.33

Table 22

CARLOAD RATES APPLYING ON PARTICLEBOARD

From Rapid City, South Dakota

effective 10/15/79

TO:	Carload Rates in cents per 100 Pounds (CWT)		Carload Rates in $/M Sq. Ft. 3/8"
Chicago, IL	187 / 70,000#		24.54
Houston, TX	287 / 60,000#	188 / Excess	37.67
Jasper, IN	340 / 40,000#		44.63
Kansas City, MO	161 / 70,000#		21.13
Los Angeles, CA	322 / 75,000#		42.26
Minneapolis, MN	129 / 70,000#		16.93
Winston-Salem, NC	284 / 50,000#	182 / Excess	37.28

Table 23

RAIL RATES, PLYWOOD/PARTICLEBOARD, October 15, 1979

(In 100 M lb. cars)

($ M Sq. ft. 3/8")

	FROM		
TO:	Portland	Augusta, GA	Lufkin, TX
Chicago	37.69	18.15	18.53
Minneapolis	33.97	26.90	25.13
Jasper City, IN	43.03	18.02	18.02
Kansas City, MO	33.97	23.60	9.26

Table 24

TRUCK RATES, PARTICLEBOARD, October 15, 1979

(Full loads)

($ M sq. ft. 3/8")

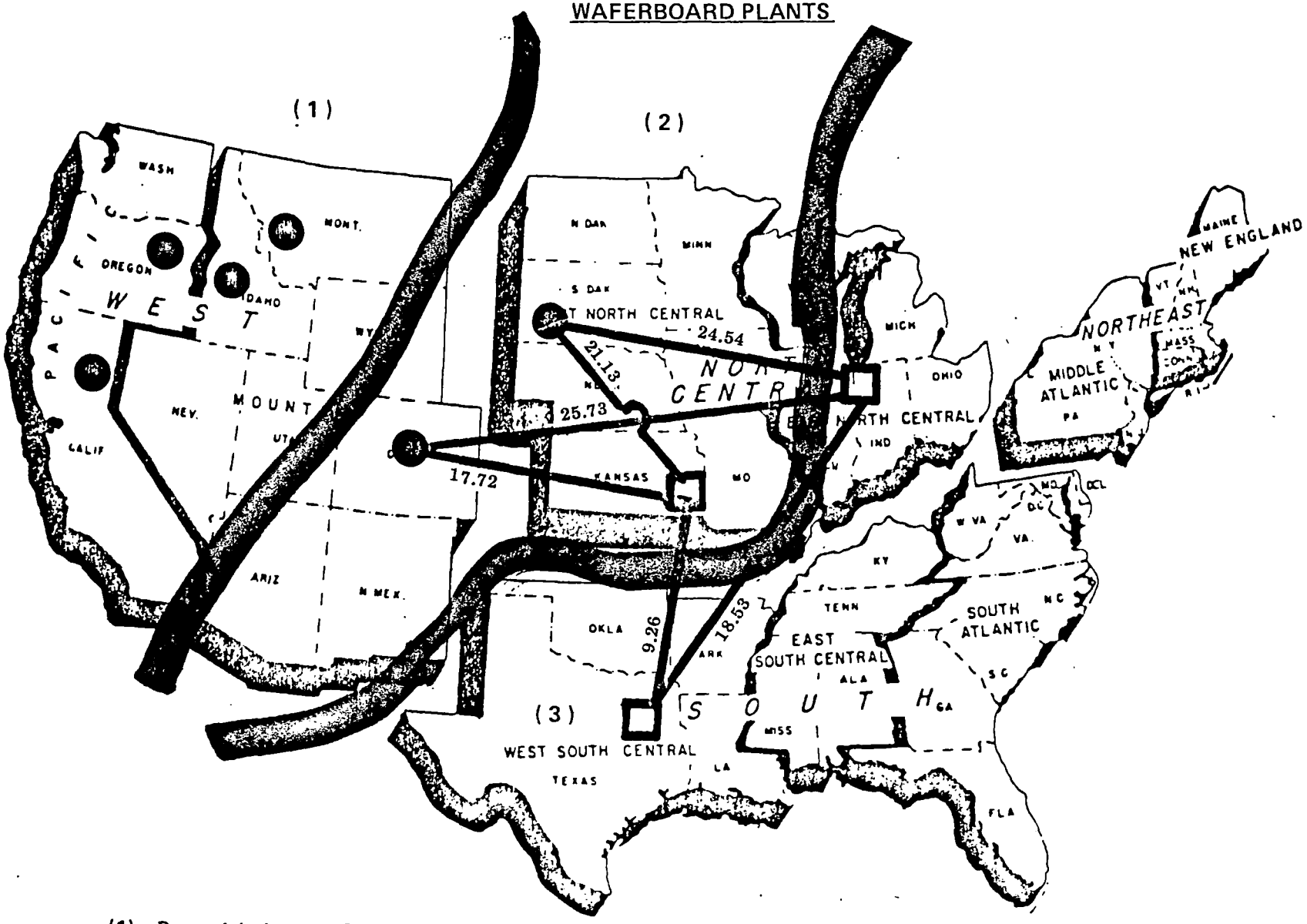
	FROM	
TO:	South Dakota	Grand Rapids, MN
Kansas City, MO	21.13	20.61
Chicago	25.33	18.76
Minneapolis	17.19	10.11
Jasper City, IN	28.88	24.81

Figure 7 shows the likely market zone for six plant locations in the dead softwood region, based on a $25 freight charge radius. The four westernmost potential sites are confined to west coast and Mountain states, which is also the area of half the U.S. sheathing plywood production. The two more easterly locations can access the West North Central Region as well as parts of the Southwest, although considerable waferboard production will emanate from Minnesota in the near future as discussed previously.

On balance, LGA judges that the most favorable sites from a freight viewpoint are Chester, California, which is close to the great Los Angeles market, and Rapid City, South Dakota, which can reach all of the West North Central and Mountain states, and as far as Chicago and Kansas City.

Figure 7

AREAS OF FREIGHT ADVANTAGES FOR DEAD SOFTWOOD REGION WAFERBOARD PLANTS



(1) Potential plants at Chester, CA; LaGrande, OR; Boise, ID; and Missoula, MT

(2) Potential plants at Rapid City, S.D. and Denver, CO

(3) Lufkin, TX point of origin for southern pine plywood

ALLOWABLE WOOD COST FOR AN INLAND MILL

For the purposes of developing an allowable wood cost, LGA will utilize data presented in Comparative Economics of Manufacturing Composition Boards from Dead Timber, Washington State University,* which was based on engineering information provided by Columbia Engineering International, of Vancouver, B.C. These data are based on costs obtaining in late 1978 and early 1979; rapid cost escalations have made them somewhat marginal by late 1979. Moreover, the price of softwood sheathing plywoods, the primary competitive and price setting material, fluctuates constantly.

LGA elects to use prices that were viable during the same period that the capital cost and operating data for a waferboard plant relate to.

Southern pine plywood sold, during the period of interest, for about $174/M 3/8" at the mill, and about $192 in Chicago. For waferboard to compete in Chicago, it should sell at 10 percent less, or $157. As we have seen, freight to Chicago from Rapid City, the closest site studied, is just under $25, providing a net mill realization of $132.

The most efficient plant design suggested by Columbia Engineering is for a 300 ton/day mill, or 150 million sq. ft. 3/8", annually, using an 8'x24'x10' opening press. Such a plant was costed then at $23.05 million. Manufacturing costs, including raw materials, labor, power, fuel, supplies, taxes, depreciation,** and administration, but not including sales costs or wood, amount to $69.13 per M, 3/8" in this plant. Assuming a 5 percent of mill net sales cost of $6.60, the total product costs are equal to $75.73 or, more generally, $76/M sq. ft. 3/8".

*Research Report 79/57-22, May, 1979. Conducted for USFS, Intermountain Forest and Range Experiment Station.

**Because depreciation is calculated on a 15 year, straight line basis, it may be understated.

However, another deduction must be made, for earned income on capital invested, since the costs cited above include no return on capital. LGA suggests that a 30 percent return before taxes (after tax income of about 15 percent) would be required to interest any private forest products firm in investing.

For the $23 million plant investment used as the basis for calculation here, the plant must generate an average of $3.53 million annually after tax income for the 15 year period over which the plant will be depreciated. Based on 150 million sq. ft. 3/8" output annually, each M sq. ft. 3/8" must bear an interest cost of $23.53. Added to the previous costs, we develop a figure of approximately $100* per M sq. ft. 3/8" for all costs, including return on capital. Allowable wood cost is then the balance of the mill revenue, or $32 per M 3/8". Using an input of 0.937 tons of dead wood per M sq. ft. 3/8", an allowable cost is generated of about $34 per ton, delivered to the mill.

MARKET VOLUME AND PROBABLE PRICE RANGE IN THE YEAR 2000

Future Markets for Waferboards

The demand for structural waferboards and related products will derive from three sources discussed before and summarized here:

(1) replacement of sheathing grade softwood plywoods and some underlayment particleboards in on-site construction applications
(2) developing a new market as a utility panel for the do-it-yourself and small contractor markets
(3) replacement of particleboards and softwood plywoods in some industrial applications.

Tables 25 and 26 enumerate the key current uses for both softwood plywood and for particleboards, and Leonard Guss Associates' analysis of the potential penetrations possible for waferboard in the nearer term future. These estimates are the basis for market projections made in this section.

*which includes the depreciation calculated in the WSU report cited of $10.24/M sq.ft. 3/8".

Table 25

POTENTIAL REPLACEMENT OF SOFTWOOD PLYWOOD BY WAFERBOARD, BY THE YEAR 2000

USE	WAFERBOARD POTENTIAL
Roof Sheathing	Up to 50% of West Coast and Southern 1/2", 3/8" CDX replaceable.
Sidewall Sheathing	75% of all plywood potentially replaceable, but usage relatively low.
Floor Systems	Just qualifying for this use under codes. Plystran has qualified. After approvals, from 1/2 to 1/3 of this use obtainable.
Miscellaneous uses - storage, shelves,counters, fascias, soffitt decks, fences, screens, inset panels, etc.	None of these are load-bearing, and, in many,waferboard's good-two-face characteristic is advantageous. Some uses require smooth surface and are not available without it. Up to a half of the market available.
Non-residential roof deck	Requires code approvals. Ability to obtain 10' panels useful. About 25% of plywood's market obtainable.
Shelters, barricades, ramps, general facilitating	Waferboard meets almost all uses better. Up to a half replaceable.
Materials handling	Some uses require high structural strength and/or are government specific for plywood. Others readily penetrable by waferboard. A fifth of plywood replaceable.
Utility panel for shoulder projects, etc.	A very large market for plywood which is a trade: repair&re consumer prefers plywood, but for many applications will accept waferboard, especially as it is promoted. Up to a third of this plywood is replaceable by waferboard, plus growth in its own right.
Furniture, fixture, and industrial parts	Small volumes of softwood plywood used, of which an estimated third is replaceable by waferboard, based on its solid core, even with its surface disadvantages.

Table 26

POTENTIAL REPLACEMENT OF PARTICLEBOARD BY WAFERBOARD, BY YEAR 2000

USE	WAFERBOARD POTENTIAL
Upholstered Chair Seats	Often uses high density, expensive particleboard; largely replaceable by waferboard.
Drawer Bottoms	Usually hardboard, minor potential for waferboard.
Shelving	Usually particleboard or MDF; limited potential for waferboard.
Tops: case goods, office furniture, tables, dinettes	Usually particleboard, MDF, or softwood plywood; minor potential for waferboard where high pressure laminates are used for finish surfaces, especially dinettes.
Utility panel for shoulder trade: repair and remodel, home	Largely dominated by softwood plywood, but some particleboards are sold for this purpose. The comment shown in Table 25 applies here. The exterior qualities of waferboard can be important.

Based on the assessment shown in the preceding two tables, LGA has quantified the potential opportunity for waterboards, based on the assumption of a price at any given time about 10 percent below that of the average mix of 1/2" CDX sheathing plywoods. As noted several times in the discussion of the individual markets, there are barriers due to code and lack of knowledge about the product that limit the current acceptance of waferboard. As these barriers are removed by increased marketing activities, the market potential will advance, assuming a favorably competitive price is maintained with softwood plywood.

The North Central region, and to a lesser extent, the Northeast, comprises the near term structural waferboard market. These regions are developing the greatest volume of supply and also are closest in access, as far as transportation costs are concerned, from the Canadian producers.

The longer term future will be somewhat different when waferboard and other structural panel plants are completed in the South and West, where softwood plywood is made, and where from half to two-thirds of it is consumed. Production in these areas will substantially enhance the market acceptability there, through transportation advantages and through increased marketing activities in those areas, based on local production.

Expansion is still going on in softwood plywood. However, creating additional softwood plywood production is not as simple as it was ten years ago. Access to suitable timber, in both the western and southern United States, is becoming more difficult with each passing year. Prices for public timber in the western United States have advanced sharply in recent years. This is, in part, a reflection of less timber being offered by the Forest Service (USFS) and Bureau of Land Management (BLM) due to environmental and other pressures on logging and timber sales practices. There has been almost no new plywood plant construction in the western United States for some time, although many improvements and additions to capacity have been made. A number of plants are being built in the South, but suitable sites are becoming scarcer.

Conversely, the wood raw materials used for waferboard are generally lower in cost than for softwood plywood and have limited alternate markets. This has been true for aspen, the main ingredient in most structural particleboards, which is still plentiful and under-utilized in the North Central, North East and Rocky Mountain areas although new plants may bring this supply under pressure. A similar situation affects mixed eastern hardwoods also being used as raw materials.

Taking all of these factors into account, LGA expects that structural panel production and consumption in the U.S. in the year 2000 will approximate 30 billion sq. ft. 3/8". Of this, about 22 billion should be softwood plywoods, comprised of 18-19 billion in sheathing grades and 3-4 billion in sanded grades and siding. The remaining 8 billion sq. ft. of structural panels should be reconstituted products, mostly waferboard types whether oriented or not. Moreover, a significant proportion of the 'softwood plywood' itself should have a reconstituted core, so that actual production of reconstituted structural products will be considerably higher than the volume used alone (that is, without veneer faces).

Obviously, such a forecast or, perhaps better, an expectation, ignores the probability that new technology will develop products not now known over the next two decades.

LGA expects that while a major segment of the reconstituted panels will be used in structural applications, an important share will be used for semi-structural ones, such as siding, or for non-structural ones, such as wall paneling. This implies our further expectation that the base reconstituted product will give rise to a class of overlayed or otherwise finished panels suitable for a broad array of uses.

It is obvious that the potential for waferboards and other structural particleboards can not be realized without supply. At this writing there are seven operating waferboard plants (excluding corestock plants) in North America, and at least nineteen other plants announced or under study. It is of interest to

recall that in the fifteen year period from 1963-78 61 softwood plywood plants were built in the South, while another half dozen are being built now or are on the drawing boards.

Such a precedent makes the prospect of building the 55 or so additional waferboard/structural particleboard plants that will be required over and above any otherwise announced building, over the next 20 years, seem reasonable.

Future Price Range for Waferboard

Added to the usual, almost unsurpassable obstacles of long range price forecasting in any field, are the normal wide fluctuations common to building materials and the high and presently unchecked rate of inflation affecting all U.S. products and markets. Therefore it is understood that LGA's 'forecast' of probable prices for waferboards in the year 2,000 is designed as a basis for discussion, and for calculating economic alternatives, rather than a serious projection of actual anticipation.

On this basis, it is first necessary to consider softwood plywood. That segment of softwood plywood which by grade and type would be most competitive with structural particleboards should still be produced in more than twice the volume of structural particleboards. Therefore the price relationships of the two products will be intertwined and not separable. Moreover, LGA expects the present price gap to narrow. Historically waferboard has been sold (most of the time) at from 10-15 percent less than softwood plywood, in order to encourage experimentation and compensate for some strength defects vis a vis plywood. By year 2,000 these accomodations should no longer be needed for the most part. Perhaps a 5 percent differential will still exist reflecting some minor product advantages for softwood plywood; perhaps no such differential will be required.

Integrating the above factors and expectations, and using the calculated current mill FOB value of $132 per M sq. ft. 3/8" as a base, LGA projects mill realization will range between $300 and $370, or, expressed another way, $335 $\pm$ $34 or $\pm$ 10 percent. Such a price 'forecast' anticipates a continuing inflation which, in those

elements which affect the price of structural panels, will range between 4 and 5 percent annually.

Volume Markets Potentially Available to the Dead Softwood Regions

Most of the western United States is reasonably accessible to a plant located in the dead softwood region, depending on just where the plant is located. The close in market, which is roughly the same regardless of location, should approximate 15 percent of the total U.S. projected consumption of 8 billion sq. ft. 3/8" of waferboard and other structural particleboards, or 1.2 billion sq. ft. in the year 2000. The secondary market includes all the consumption west of the Mississippi and, in a few cases, locations a little more easterly. This additional market should reach 2.8 billion sq. ft. 3/8" in year 2,000. The total accessible market in which the Inland West would have freight advantages or parity would then reach half the projected total, or 4 billion sq. ft. 3/8".

PARTICLEBOARDS

BACKGROUND

The particleboard industry developed in Europe prior to World War II in response to the need for high quality wood base panels which could be manufactured from the largely marginal forest resources there. Particleboard was introduced in North America in 1938, and the early plants here were based on European technology. By the late 1950's, however, the European concepts were modified to conform to the raw materials, marketing and general economic conditions peculiar to the major United States markets.

The history of particleboard production in the United States has been one of substantial overall growth, reaching to over 3.7 billion square feet in 1978. Growth was steady except for the 1973-75 dip when the fall-off in conventional housing starts hurt the underlayment segment of the product mix. At the same time, industrial board declined sharply due to lower consumption within the furniture industry, and the decline in mobile homes severely hit the mobile home decking portion of the urea particleboard business.

Since 1970, two new types of reconstituted board have become important. The first is the fiber type of platen board usually referred to as medium density fiberboard (MDF), developed in the late 1960's, but prominent only since 1972. This is consumed mostly in furniture and cabinetry; minor but increasing volumes are sold into millwork and other applications in competition with lumber. It is discussed in a separate section.

The second is the Mende system, which uses a continuous process to make thin boards of particles or fiber which are primarily for paneling. This production began to come into the marketplace in volume in 1973. The Mende process is used worldwide, with considerable success. However, despite significant investments in plant and development by such firms as Georgia-Pacific, this process has never met a similar success in the U.S.

Table 27

U.S. PRODUCTION OF PARTICLEBOARD BY METHOD

MILLION SQ. FT. 3/4"

	PLATEN	EXTRUDED	MENDE	TOTAL
1965	753	50	---	803
1970	1,731	32	---	1,763
1975	2,331	36	150	2,417
1976	3,014	13	175	3,202
1977	3,384	24	185	3,593
1978	3,720[1]	24	195	3,939

SOURCE: U.S. Department of Commerce: Platenboard and Extruded Particleboard; 1965-77

National Particleboard Association, 1978

[1]Data includes limited quantities of structural particleboards.

Total production of particleboards and medium density fiberboards by method of production is shown in Table 27. As shown here, extrusion board, an old technology producing a low quality product, is made in insignificant quantities, and only in captive facilities.

A limited volume of domestically produced structural phenolic particleboards is included in the total platenboard.

The three major markets for particleboard are underlayment, mobile home decking, and industrial boards used primarily in furniture and cabinetry operations. Underlayment is a grade and not necessarily a use. That is, portions of nominal underlayment products are used as corestock in the manufacture of less expensive kitchen cabinetry and case goods. The majority of underlayment is, however, used for flooring under carpet and tile surfaces. This underlayment application is essentially non-structural in nature; the particleboard is used as a leveling course in the floor system to provide a smooth surface under floor

covering materials. Generally, underlayment comprises about 30 percent of U.S. production with industrial grades accounting for about 60 percent and mobile home decking accounting for the balance (See Table 28).

Table 28

PRODUCTION OF PLATENBOARD PARTICLEBOARD BY GRADE - 1970 - 78

(Million Sq. Ft., 3/4")

	Under-layment	Mobile Home Deck	Industrial & other	Total
1970	596	N.A.	1,135	1,731
1971	753	N.A.	1,605.	2,358
1972	941	N.A.	2,137	3,078
1973	891	462	2,108	3,461
1974	891	312	1,862	3,065
1975	747	226	1,358	3,231
1976	1,092	277	1,645	3,014
1977	1,097	289	2,207	3,593
1978	1,149	274	2,222	3,645[1]

[1] excludes structural particleboard

SOURCE: U.S. Department of Commerce; 1970 - 1975
N.P.A. 1976 - 1978

The industrial market for particleboard is heavy to 3/4" thickness (about 40 percent), 5/8" (about 21 percent) and 1/2" (about 16 percent). While over a ten year span there has been some modest movement towards 5/8" panels from the 3/4" thickness by users in order to reduce board costs, generally these three thicknesses have been and undoubtedly will remain the most popular.

The primary production areas for particleboard draw from the western and southern forests, paralleling the production of softwood plywood. However, additional quantities of particleboard are manufactured outside these two

primary producing areas, as residues and other low cost wood raw materials in appropriate quantities are available in other locales. This is not the case for softwood plywood whose production is restricted to those areas where suitable logs occur.

Of the 64 particleboard plants operating at the present time, 34 are in the southern states, 7 in the northern states and 23 in the West. The production in the western states is largely confined to California and Oregon which have 19 of the 23 western mills. (See Table 29).

Table 29

PARTICLEBOARD PLANTS BY STATE, 1978

South		North		West	
Alabama	3	Indiana	2	California	7
Arkansas	3	Michigan	1	Idaho	1
Florida	1	Minnesota	1	Montana	1
Georgia	3	Pennsylvania	1	New Mexico	1
Kentucky	2	Wisconsin	2	Oregon	12
Louisiana	3	TOTAL	7	Washington	1
Mississippi	2			TOTAL	23
North Carolina	5				
Oklahoma	1				
South Carolina	1				
Tennessee	1				
Texas	3				
Virginia	6				
TOTAL	34				

SOURCE: Directory of the Forest Products Industry, 1978

Production in the South is fairly uniformly spread across a large geographical area, from eastern Texas through the southern states, including Virginia and North Carolina. The leading southern states in particleboard production include Virginia, North Carolina, Mississippi, Louisiana, Georgia and Alabama.

While the number of southern plants exceeds the number of western plants, the western plants produce more board per plant than do their counterparts in the South. Several of the western plants are considerably larger than the average plant in the South. In total, the western plants produce about 44 percent of particleboard, excluding medium density fiberboard. (See Table 30). The western plants, due to the quality of their furnish and the characteristics of the final board, have provided more of the total industrial particleboard used than have the southern mills. Western plants, for example, produced 54 percent of the industrial particleboards in 1978, in contrast to their 44 percent share of the total board produced in that year. Actually, in the late 1960's, the western plants were producing from two-thirds to three-quarters of all the nations' industrial particleboard.

Table 30

1978 PARTICLEBOARD PRODUCTION BY GRADE AND REGION

(Million sq. ft. 3/4")

	South & East		West		Total	
Underlayment	792	(70%)	357	(30%)	1,194	(100%)
Mobile Home Deck	187	(68%)	87	(32%)	274	(100%)
Industrial	837	(46%)	992	(54%)	1,829	(100%)
Other[1]	211	(55%)	175	(45%)	386	(100%)

[1] includes shelving, door core, structural, miscellaneous

SOURCE: National Particleboard Association

Southern plants typically, until the late 1960's, produced only underlayment and mobile home decking. Towards the latter part of the 1960's and early 1970's, some of the southern plants began to produce and successfully market industrial grade particleboards, particularly to the southern furniture producing areas. Major southern producers, including Duraflake, Kirby, Georgia-Pacific, Champion, Masonite, Weyerhaeuser, M & B and Union Camp, all operating mills with 5 foot presses, began to place greater emphasis on the production and marketing of industrial grade southern particleboard during the 1970's.

This trend towards greater production and consumption of southern industrial particleboards within the southern region has been encouraged by (1) increasing freight rates on products shipped from the western states; (2) improved quality of southern industrial boards, and (3) increased marketing effort by southern producers.

Announced capacity during 1978 for the particleboard industry was 4.376 billion sq. ft., 3/4" including all urea platen, extrusion, and Mende plants, excluding only the single phenolic waferboard operation then extant. With a production of 3.939 billion sq. ft., 3/4" in 1978, the industry operated at the rate of 90 percent. In view of the necessary down time, and the fact that "capacity" estimates are based on a single product making most effective use of the press, while in reality a number of different products, of different thicknesses requiring different cycle times in the press are routinely manufactured, **the industry was actually operating at its effective capacity in 1978.**

MARKETS AND APPLICATIONS

The industrial market has always been the largest, the most stable, and the market offering the highest price per thousand for standard particleboard products. Sixty-one percent of 1978 production was industrial grade, plus some unknown but significant industrial use of other grades. The industrial applications for particleboard are quite varied, but the largest use, by far, is in furniture and cabinetry where it is used as tops, sides, doors, fronts, shelving, drawer fronts and sides, seats, etc., not only in casegoods, tables and other

household furniture, but also in manufactured kitchen cabinets, electronics goods cabinets, office furniture products, and store fixtures. Substantial quantities are also used in the production of door cores, wall paneling, toys, sporting goods, and leisure and hobby products, such as pool, table tennis, game boards, and shuffle boards.

In the period prior to 1970, particleboard core, with a veneer or other overlay or printed surface, was being introduced for casegoods and cabinets in competition with hardwood plywoods and lumber. By the early 1970's, particleboard had established a secure base, and its use and acceptability grew in furniture and related cabinet production, primarily in lower price lines.

The industrial particleboard market showed consistent growth throughout the early 1970's. New methods of marketing furniture had begun to be developed (i.e. Levitz and other mass merchandisers). Strong mobile home production was also an important factor, since mobile homes are sold furnished. Multi-family housing construction was at a very high level, requiring major quantities of cabinetry which used higher percentages of particleboard than the cabinetry used in single-family dwellings.

Furniture production and consumption had grown steadily from the mid-1960's until 1974. This pattern broke for a combination of reasons: recession, drastic fall-off in multi-family and mobile home production, and an erosion of consumer confidence. The resulting sharp decline can best be noted in the Federal Reserve Board's Index of Household Furniture Production, which fell from about 150 in late 1972 to below 120 in early 1975 (See Figure 8). The FRB Index of Fixtures and Other Furniture climbed sharply in the first quarter of 1976, and remained strong in 1978. Household furniture recovered at a slightly slower rate. By the end of 1978, both indexes were at record levels.

The 1974 downturn in furniture production was the first of consequence since World War II, and the effect was quickly translated to particleboard producers, both in the volume of shipments to the industrial users and in a lowering of the prices paid for industrial particleboard.

Furniture volume losses were primarily in the lower and middle price line of furniture. Some makers of high value lines actually had some of their best years during the furniture recession of 1974-75. Conversely, those lower cost/quality producers, who use the major share of particleboard, suffered severe reverses, including plant shut-downs.

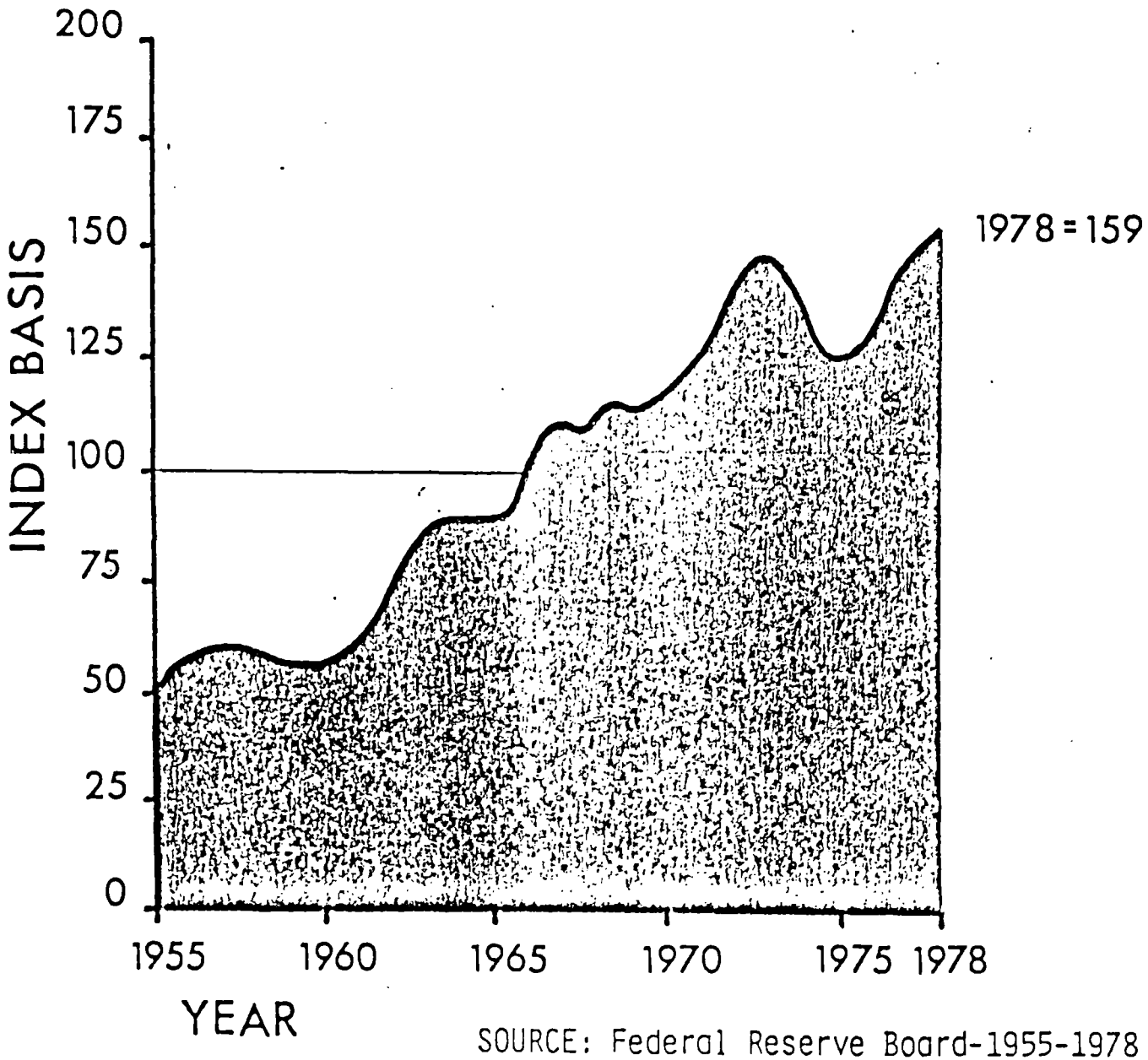
The production of mobile homes slumped dramatically in the 1973-5 period, and in fact, has never fully recovered the earlier peak. While the strongest effect of reduced mobile home production on particleboard is in the lesser amounts of mobile home decking utilized, demand was also reduced for the lower line furniture that is traditionally sold as a part of the mobile home, as well as the cabinetry that is included. The latter two products frequently utilize industrial particleboards and the burden of reduced demand was felt by the producers of industrial board.

The multi-family housing market also took a severe drubbing in 1974-75, so that kitchen cabinetry was seriously set back, especially in the price lines that are used for multi-family dwellings and lower cost dwellings. Better cabinetry that goes into family homes was not so harshly treated, since single family construction held up fairly well and, in fact, the higher priced housing segment did quite well, providing a market for better cabinetry. Also, the aftermarket was reasonably strong, a market which is heavy to middle and upper line cabinets.

Figure 8

Index of Household Furniture Production

(1967=100)



SOURCE: Federal Reserve Board-1955-1978

The furniture industry, itself, has changed drastically in the last 30 to 40 years. Originally, furniture plants sawed their own hardwood lumber from logs, dried it, milled it, and in effect, produced the entire furniture piece from products manufactured on the premises. Today, the typical furniture plant is more of an assembly plant, buying partially cut-to-size pieces and other components for assembly, finishing, and marketing.

The industry still has many small producers, located mostly in the South. The latest national data, (1977 Census of Manufacturers) established that about 63 percent of wood household furniture was produced in the southern states, the same proportion as 1972. The northern states produced only 27 percent of wood household furniture, with the western states producing the remaining 10 percent.

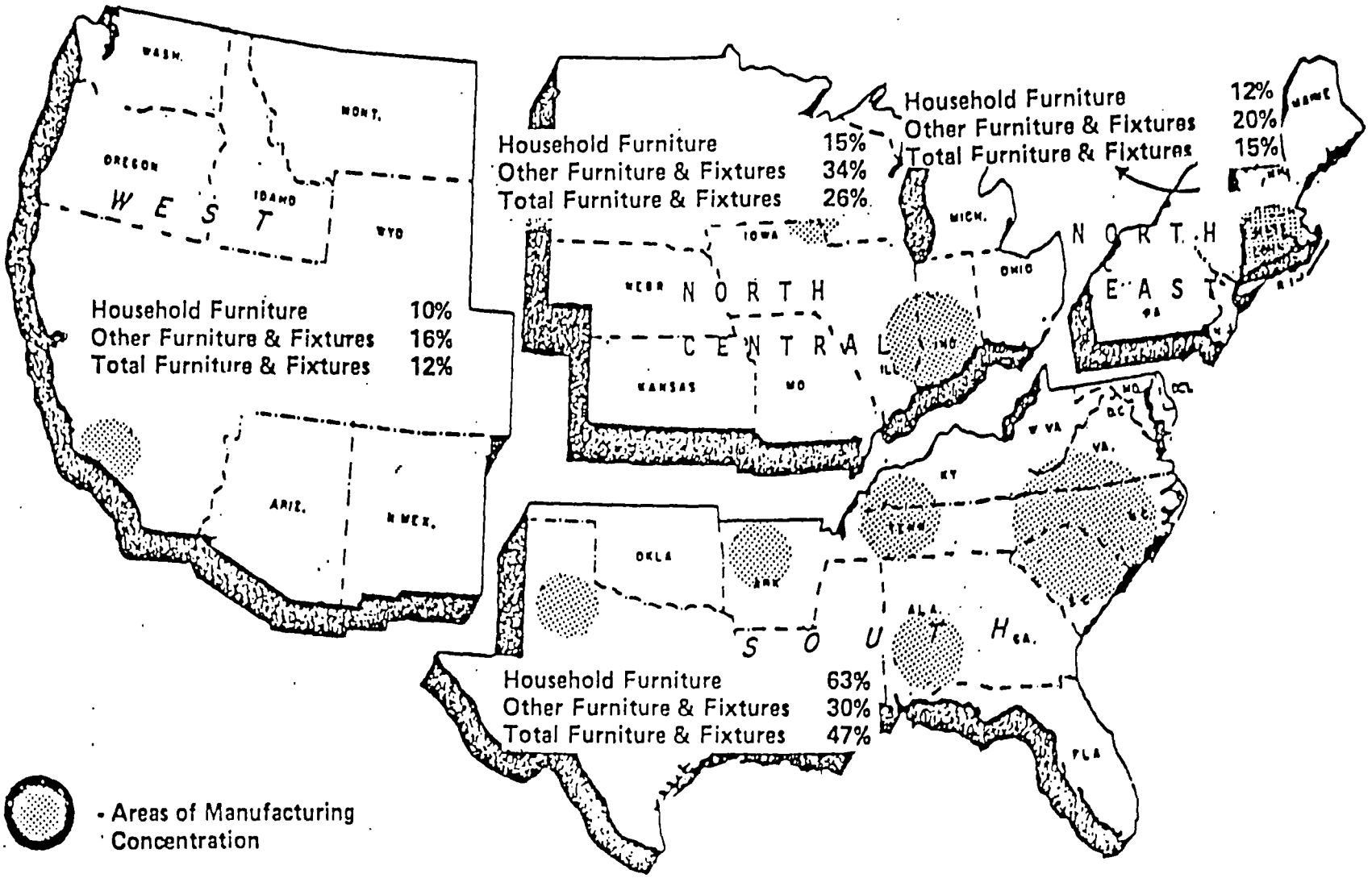
The regional distribution of non-household wood furniture and fixtures (office furniture, store fixtures) differs. The northern states accounted for 54 percent of this production; the southern states produced only 30 percent of the non-household types and 16 percent were produced in the western states.

Factory produced wood kitchen cabinets have a third regional pattern: 49 percent of the wood kitchen cabinets are produced in the northern states, but only 30 percent produced in the southern states. The western states produced 21 percent of the wood kitchen cabinets.

The distribution of all wood furniture and cabinetry production is shown in Figure 9.

Figure 9

DISTRIBUTION OF WOOD FURNITURE AND CABINETRY PRODUCTION (All Types)



Within the western region, practically all of the household furniture is produced in the Los Angeles area, with other furniture and fixture production, as well as kitchen cabinet manufacturing scattered throughout the Pacific and Mountain states. Within the South, the largest production area is in North Carolina. Another important center in furniture production is just outside of the southern states in southern Indiana. This area not only produces significant quantities of furniture and fixtures, but also has fabricating plants which prepare many components for southern furniture plants, utilizing particleboard as a core material. On an overall basis, the South produces about 47 percnt of the total furniture and cabintery in the United States, the northern states produce 41 percent and the western states only about 12 percent.

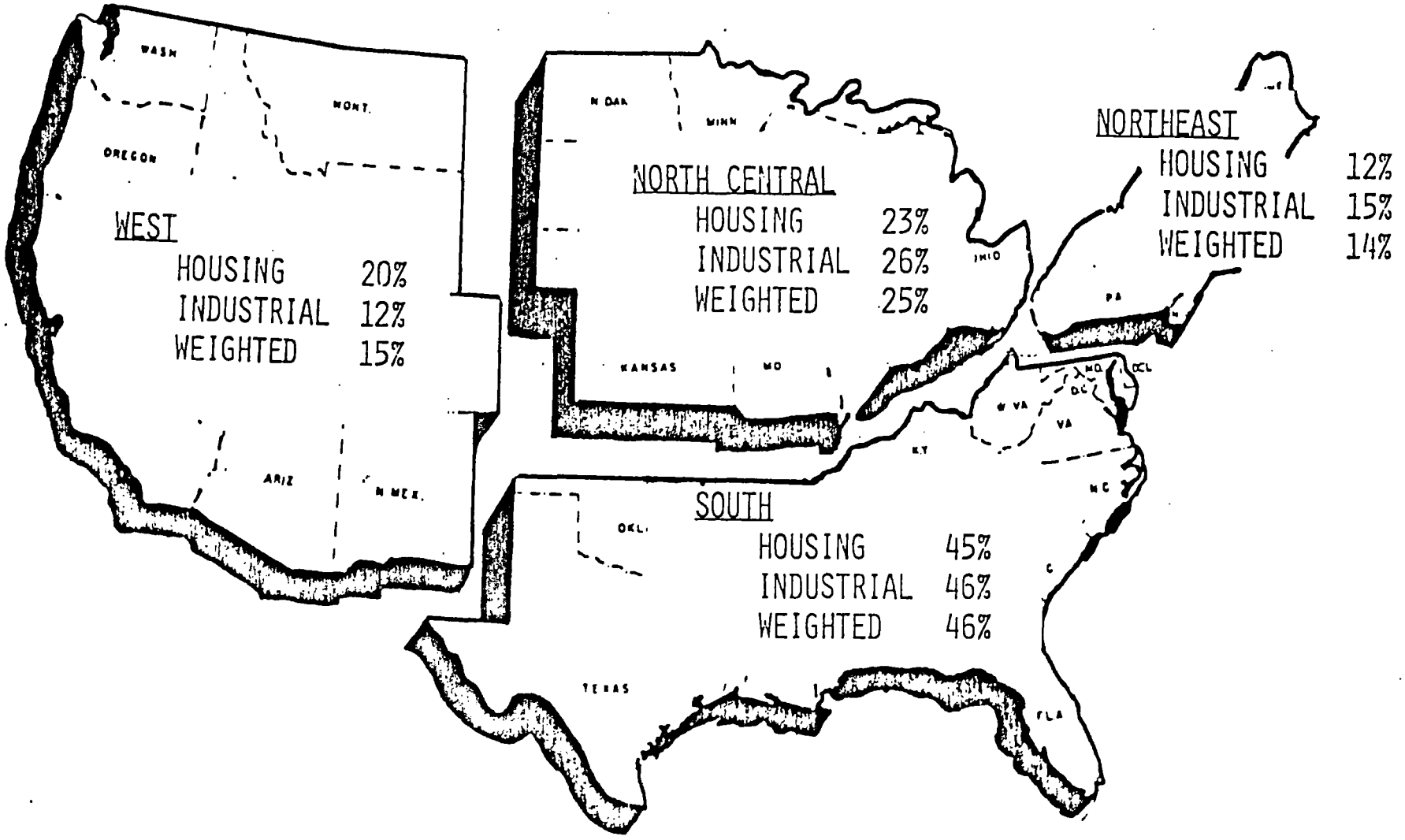
Thus, the locations of the plants **consuming** industrial particleboard are primarily in the eastern half of the U.S. Conversely, the **production** of industrial grade particleboard is approximately evenly split between the areas east of the Rocky Mountains and the Western states.

Particleboard consumption is determined not only by its industrial markets, but by housing start locations as well. As already noted, particleboard's primary use in housing is as underlayment, under tile or sheet goods in kitchens, baths, recreational rooms and similar spaces. Particleboard is also used for some moldings, shelving, and a number of miscellaneous applications in on-site housing.

Figure 10 shows the consumption of particleboard by broad region of the U.S. wherein appropriate weights are given to the two major markets. Industrial particleboard alone has a geographic consumption pattern that would closely follow the furniture production data shown in Figure 9.

Figure 10

PARTICLEBOARD CONSUMPTION BY REGION



Market Acceptance

Since all industrial particleboard is eventually finished, either by the producing mill, the customer, or a custom finisher/fabricator,surface smoothness is important. Finishing approaches are described in a later section. Sawlife and abrasion characteristics are always of interest to fabricators and those who work with particleboard, but the relative importance of this factor has somewhat diminished as nearly all fabricators are now using carbide tools which provide much greater sawlife than the carbon steel types originally used. Screw-holding power is required for strong joining, especially in such items as dinette tabletops. A high internal bond (IB) is required for applications that require some strength: moldings, shelvings, larger furniture parts. Resistance to ambient moisture (if not to water directly) is required for durability. There are others which are specific to a given end use.

One on-going controversy surrounds the use of mobile-home deck and of particleboard wall paneling in mobile homes. The urea-formaldehyde used as binder in each case gives rise to odors and fumes, both objectionable to many. There is concern among users and producers of particleboards regarding the amount of formaldehyde per million parts of air that may become subject to regulation. One outcome could be the use of phenolic resins in place of urea-formaldehyde, either in conventional particleboards or in a waferboard.

Distribution

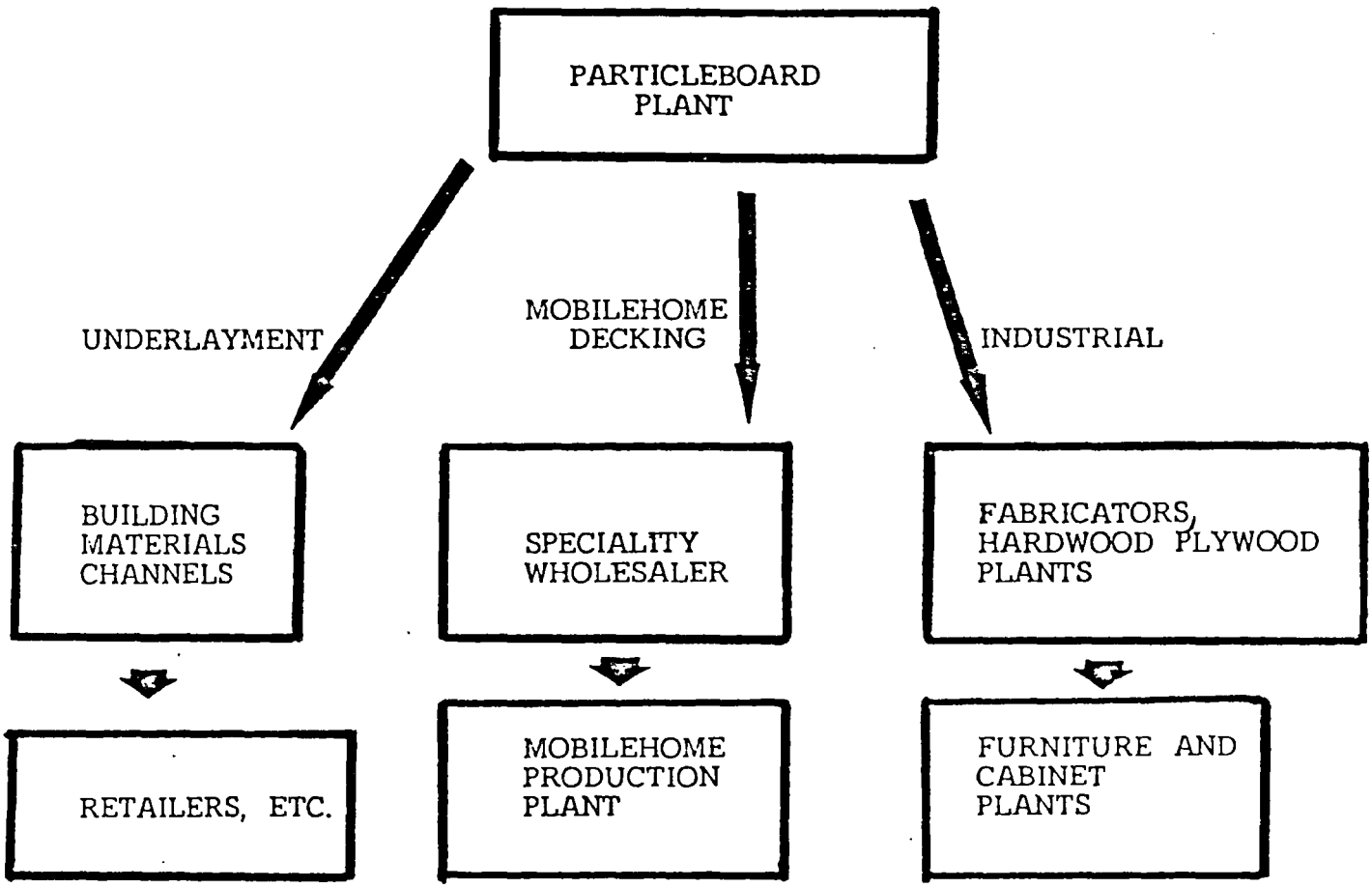
The distribution of particleboard varies according to the type and market - often the same thing. (Figure 11) Underlayment used as underlayment is a building material and flows through standard building material channels, like plywood or waferboard, as described in the previous chapter. Sales are made to a stocking wholesaler (or a buying arm of a retail chain) who breaks bulk and sells liftloads to retailers or, in some cases, direct to contractors.

Mobile home deck is an industrial product, usually sold direct either by mill salespeople or brokers. Sales are usually made on the telephone

Figure 11

PARTICLEBOARD

DISTRIBUTION CHANNELS



with occasional field calls to renew and affirm relationships, perform trouble-shooting and introduce new concepts. Most mobile home deck is stocked by specialty wholesalers for mobile home plants in geographic areas where a number of such plants are located. The plants themselves maintain no inventories.

Industrial particleboards, including underlayment grade sold for industrial purposes, is usually sold mill direct, to furniture firms or other converters. Some of it is stocked by industrial wholesalers who supply smaller firms whose requirements can not meet the minimums for truckload shipment from the mill.

However, there is an additional channel employed here, the industrial fabricator. A considerable amount of work can not be suitably performed on particleboard either at the producing mill or in the customer's factory. This may be cut-up, or machining, or finishing. A number of fabricating firms in the South and West have arisen to perform these services, often on an in-transit basis. These operate as cut-to-size fabricators and/or as hardwood plywood manufacturers or other overlayers who ship a component part that is not only reduced from the standard mill size, but also has some face finishing done to it enroute from the mill to the furniture plant.

Approximately one-third of mill shipments of industrial particleboard are shipped cut-to-size as opposed to standard size panels. The percentage furnished cut-to-size is actually higher for the southern mills than for the western mills. Generally, about two-thirds of all particleboard purchased by the furniture, fixtures, and cabinetry manufacturer is purchased cut-to-size. The difference in cut-to-size volumes between the mill shipments and the receipts at the furniture plants is accomplished via middle-men. Southern mills also, quite obviously, ship a higher percentage of their product by truck to the furniture producers than do the western mills who rely to a larger extent on rail for transcontinental shipments.

PRICING STRUCTURE

The market prices for industrial particleboards are, like most other forest products, established as the result of supply/demand positions. There are several dozen independently owned and managed supplying organizations nationwide and several hundred significant customers seeking to purchase these products. As noted earlier (Figure 9), the demand for industrial board is regionally skewed to the areas east of the Mississippi while the supply is almost equally divided between the western and other U.S. states. With transcontinental rail freight rates exceeding $100 per thousand sq. ft. 3/4" southern mills obtain the greatest return at the mill level followed by the inland and then the coast producers.

At this writing (November, 1979), the mills in the western part of the southern region are pricing their 3/4" industrial grade material at $155/thousand fob mill, mills of the west coast are at $150 less 5 percent while inland mills receive $155 less 5 percent. These prices are sharply off from the end of 1978. Actually, from an industrial customer preference, inland western board, usually with pine furnish, is a preferred item, with coast board second and southern board third.

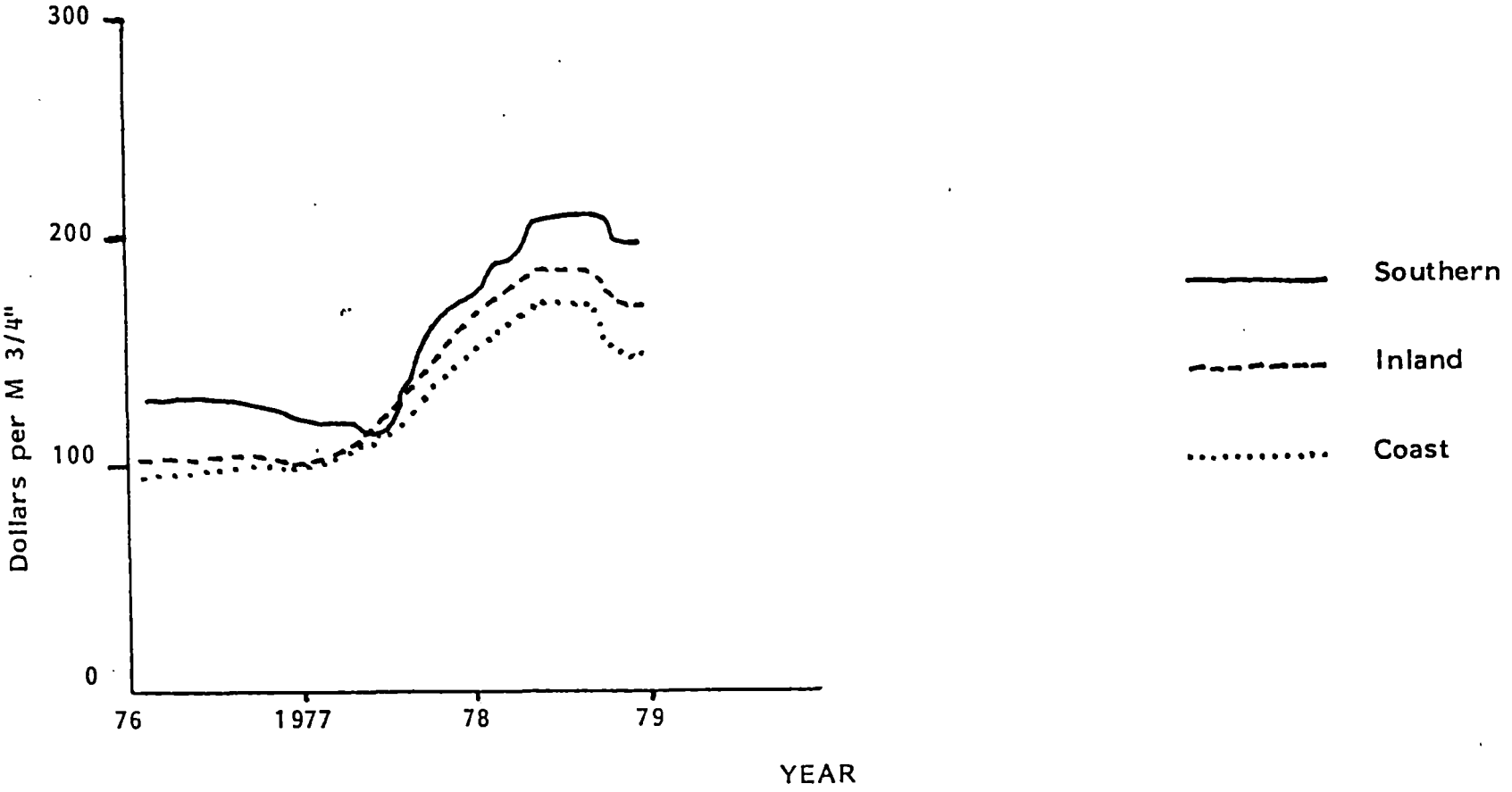
Figure 12 illustrates the changing mill price levels for industrial board during the period of 1976 through 1978. During this three year period the supply (capacity) of the industry was relatively constant. Earlier in 1973 through 1975 substantial increases in supply came on stream but since 1976 there has been very little change in supply. The price rise in 1977 and 1978 essentially reflects additional demand against a static supply, with the industry operating close to capacity. Hence occured the sharp price rise in industrial prices from the $100 to $120 price range that typified 1976 and 1977 to the $180 to $200 level that was typical of the summer of 1978. Since then a slackening in demand has lowered prices up to $45 per M.

Underlayment demand and prices depend on housing demand; wide fluctuations are the rule, not the exception. These variations are shown in Figure 13, which shows that over the last five years prices trebled from their low point to their high point.

Figure 12

INDUSTRIAL GRADE PARTICLEBOARD PRICES

FOB NET MILL PRICE PER M 3/4"



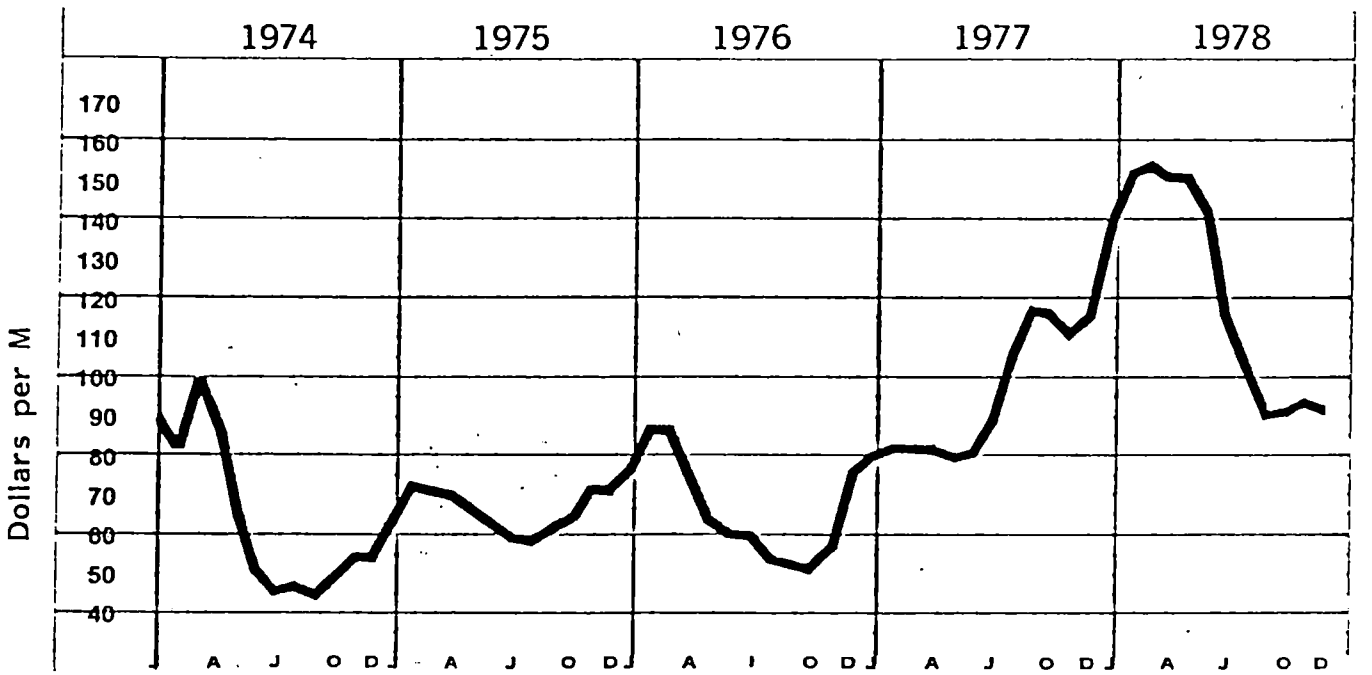
Source: Crow's

Figure 13

Particleboard, Southern

5/8", Interior Underlayment

(Prices Net, f.o.b. Mill, Central Zone)



Source: RANDOM LENGTHS Annual Yearbook 1978

At the current time, western underlayment is selling for $134 per M, 3/4", less two discounts: 5% and 3%, or a mill net of $123½. At the same time southern underlayment is selling, mill net, for $129. to $135. These prices are well off the highs of the peak housing demand in 1978 and earlier in 1979.

Mobilehome deck prices are, of course, a function of demand for mobile homes. This form of housing has never recovered to the 1973 peak, from which it fell to half the peak volume. Recent years have seen a slow climb, but never to more than 60 percent or so of the previous level of demand. As a result mobilehome decking sells currently for $135 less 5% per M 3/4" at the western mills, not much more than underlayment. Mobilehome deck brings considerably more to the southern mills, especially those in the eastern areas where a great deal of mobile home production is concentrated. Current net mill prices there are $160 per M 3/4", or about $32 more per M than western realizations.

Table 31 displays the average mill prices for the total product mix of particleboards. Note that prices peaked in 1969 and did not exceed this level until eight years later, despite much greater demand. This was the result of many plants coming into production at or about the same time. Although demand in 1978 reached a new high, still it exceeded the previous peak of 1973 by less than 6 percent yet, prices doubled in five years. This was a function of rising costs and also of pressure against a plant capacity diminished by closures during the preceding, unprofitable years.

Table 31

U.S. PRODUCTION AND AVERAGE FOB MILL PRICE
PER M FOR PARTICLEBOARD
1968 to 1978

Year	Production Billions Sq. Ft. 3/4"	Average Sales Price Per M Sq. Ft. 3/4" FOB Mill
1968	1.4	103.44
1969	1.7	124.31
1970	1.8	95.91
1971	2.4	89.71
1972	3.1	94.49
1973	3.5	113.59
1974	3.1	116.25
1975	2.5	107.93
1976	3.2	114.82
1977	3.6	136.43
1978	3.7	220.01

SOURCE: LGA calculations

REQUIREMENTS FOR COMPETITIVE MARKETING OF DEAD SOFTWOOD BASED PARTICLEBOARD PRODUCTS

The conclusions of the technical assessments of dead softwood furnish for particleboards were presented in the previous section. They were that, for all practical purposes, dead furnish is as satisfactory as greenwood except in two regards:

- ... the use of dead ponderosa pine from the Front Range would probably cause the resultant board to be grayish, because of the blue stain present in this species, and
- ... dead softwood roundwood is likely to contain more dirt than greenwood so that particleboard made from the former would probably be more abrasive than that made from the latter.

However, each of these negative outcomes is speculative, especially the degree to which they would affect the board.

Therefore the requirements for competitive marketing of particleboard made from dead softwood are the same as for any particleboard mill:

(1) a full range of widths and thicknesses to incorporate the competitive range (4' and 5' widths; 3/8", 1/2", 5/8", 3/4" and other, less common thicknesses; 8, 9, 10, 14 ft. lengths) depending on markets.

(2) a well manufactured product with physical properties (IB, swell, screwholding, MOE, MOR, etc) that meet CS 236-66.

(3) well packed

(4) shippable by truck and rail

(5) adequate cut-to-size capabilities

(6) good distribution including a competent sales force selling to stocking wholesalers, chain retailers, mobilehome manufacturers, furniture and cabinetry manufacturers, and others.

(7) good marketing support, including a sample program, technical brochures, technical sales service and other standard features.

ADVANTAGES AND DISADVANTAGES OF PRODUCTION IN THE INLAND REGION

It is clear that there are no particular advantages or disadvantages to the Inland region vis a vis other regions that bar or even seriously affect the manufacture of particleboards. There are, after all, eight particleboard plants now operating in this region, making underlayment, mobilehome deck and industrial board. The only disadvantage that these plants, or any others, face is freight to the large southern and some mid-western furniture and cabinetry markets.

However, it is possible based on available information to sort out what particleboard opportunities, if any, do exist in the Inland Region.

These must be considered separately for each of the three particleboard types under consideration.

Underlayment

There are no advantages to the manufacture of underlayment in the dead softwood area and some significant disadvantages. (1) The product is mostly employed in new housing, although some minor share is used as an inexpensive industrial board. The dead softwood region is far from major housing markets in the South and East. (2) Underlayment generally is in relative overcapacity. In recent times a number of such mills have closed or converted to other products. This is reflected in currently low prices for underlayment. (3) Underlayment is suited to southern species, and considerable capacity exists in the South, which is the locus of the largest housing markets. There is no preference for western species. (4) Underlayment mills now exist in the dead softwood region, and close to the western market which it could serve.

Mobile Home Deck

LGA views the potential for mobilehome deck in a quite similar, negative vein. The major mobilehome manufacturing regions, as already discussed, are far from

the dead softwood region. Moreover, mobilehome deck is not usually made as a single product line, but in a plant that also makes underlayment. Finally, the recent severe decline in mobilehome production, and the very slow recovery to a level still only about 60 percent of former peaks, is not encouraging for a new supplier. As a result of this slack in demand, mill prices for mobilehome deck are not much better than for underlayment, as discussed in the preceding section.

Industrial

To the extent that an opportunity exists for particleboard in the dead softwood region, it is likely to be confined to industrial board. This product class generates the highest mill return for particleboard which enables it to better bear the very high freight costs to markets in the Midwest and South. Inland panels from a new industrial plant would be at no worse than the present disadvantage in terms of freight costs to ship to southern furniture markets. The net impact of such a freight disadvantage is simply a lower mill net for an Inland mill. However, there are furniture and cabinet markets in southern California and in the Arkansas - east Texas areas. While the California market is oversupplied due to the presence of many West Coast mills, the markets in Arkansas and east Texas are not so amply provisioned. It is here that the major markets are likely to be found for a new mill venture.

Another disadvantage for industrial board here depends on the extent of ponderosa pine furnish which would generate blue stain and thus, presumably, give a grayish cast to the panel. Industrial particleboard buyers usually exhibit a strong preference for lighter color panels which is, in fact, a usual advantage of ponderosa pine furnish. LGA expects there to be some reluctance to accepting a particleboard which is significantly darker in color than other pine products. The single advantage is again a pine furnish, which is highly regarded as a particleboard raw material for its presumed ease of milling (easier machining, clean cutting without tearout, longer tool life) and other qualities among which, unfortunately, is light color.

Freight

The applicable freight rate information has been presented in the previous chapter Tables 17-22. Freight charges to the major southern markets from a dead softwood region mill will range from $75 to $100+ per M sq. ft. 3/4". This is also what freight burden industrial board from existing mills in the Inland and West Coast regions must bear. In contrast, southern mills deliver their industrial board by truck, often at freight costs of $10 per M sq. ft. 3/4" or less. The freight disadvantage of a dead softwood mill to the large midwest (southern Indiana) furniture markets is almost as severe, approximating $90 per M sq. ft. 3/4"; even though the distance is less, tariffs are unfavorable. In contrast southern particleboards deliver for only about $36 per M.

ALLOWABLE WOOD COST FOR AN INLAND MILL

Because of LGA's assessment that opportunity exists, if at all, only in industrial particleboard, the cost analysis presented here is based on that product. Production costs data are derived from Comparative Economics of Manufacturing Composition Boards from Dead Timber, as cited in the waferboard section.

Prices for industrial particleboards FOB inland mills during 1978 ranged from $165 to $195 per M 3/4", averaging about $185. The more efficient mill design developed by Columbia Engineering for the report cited calls for a capital investment of $19.70 million, plus land. Using a 5' x 24' x 12 opening press, it would produce 70 million sq. ft. 3/4" or about 300 tons/day. All manufacturing costs (excluding wood, sales expenses and a return to capital) are $122.09. If sales expense is assumed at 5 percent, or $9.25 per M, and if a **30 percent return** prior to taxes is required to interest any private manufacturing firm, or about $40 per M, then all costs, except wood, total $171.35 per M. In 1978 this would have allowed about $13.65 per M 3/4" for wood, or about $6.83 per o.d. ton, delivered to the mill.*

Using sales prices that exist today, or that were current in 1974-77, the mill would not be able to operate profitably were wood delivered to it free.

*based on 2 tons of wood/MSF 3/4" for 55 lb./ft.^{3} bd. as per the WSU report.

MARKET VOLUME AND PROBABLE PRICE RANGE IN THE YEAR 2000

The growth of industrial particleboard depends on (1) the growth of its major markets, cabinetry and furniture. Although there are other important uses, these latter are not determining. (2) the availability of competitive materials, such as hardwood lumber, hardwood plywood and medium density fiberboard.

Furniture has been on an overall upward trend for several decades and there seems little reason why this should not continue over the next two decades. On that basis LGA expects the Federal Reserve Board Index for wood household furniture to be at about 300, compared to today's 159.

However, there is considerable discussion in the industry today as to whether industrial particleboard or MDF will benefit from growth in furniture industry demand. LGA believes that most growth will go to MDF, but that some new industrial particleboard capacity will be installed. Industrial particleboard is somewhat cheaper to make and serves many functions as well as MDF.

On the other hand, LGA does not expect an upsurge in U.S. production of furniture grade hardwood lumber and veneer.

Taking these factors into account, LGA expects that industrial particleboard production and consumption in 2000 will approximate 3 billion sq. ft. 3/4", equivalent to just under 2 percent per year growth from 1978's 2.2 billion.

Since plants in 1978 were operating at about their effective capacity, this expectation requires about 12 new plants in the next two decades or their equivalents in added capacity. Raw material thus becomes a consideration.

The history of this industry in the U.S. indicates that **the most important factor influencing the location, nature, and cost structure of plants has been the environmental and economic need to utilize the large supply of residuals generated by lumber and plywood mills.** In recent years, the amount of these residuals per thousand board feet of lumber or plywood manufactured has been

increasing. This increase, principally in coarse residues, is due to the decreasing size and quality of the average log put through these operations, despite improving sawmill and peeling technology. Coarse residues are chippable, and much of this material is used for higher valued chips supplying the pulp, hardboard or chip export markets, rather than for the lower-valued particleboard raw material markets which depend largely on planer shavings and sawdust, except in times of competition for raw materials due to lumber mill shut downs.

The total supply of nonchippable softwood mill waste has been estimated at between 12 and 15 million tons a year. At the 1978 level of particleboard production, this industry consumed approximately 6 million tons of wood raw material. In the southern regions, the softwood mill waste is somewhat over 4 million tons a year, and this amount is almost totally consumed by the particleboard industry and pulp operations. It has become difficult to locate any sizeable volumes of unused softwood residues, especially as fuel oil and other energy costs have soared. On the other hand, in the western regions, the supply of softwood mill waste is theoretically, in general, sufficient to allow for some expansion of western board production. However, environmental restrictions and the great and expensive distance from markets act as severe constraints.

Two additional sources of raw material for board plants are possible, but only very partially used. The first is the residues from secondary manufacturing plants which are not used in further manufacturing operations or as fuel. The second is from slash and material now left in the woods during and after logging operations. Recent studies indicate that from 6 to 16 percent of the current timber output is still being left as residue in logging operations. Although there are economic and environmental reasons for utilizing this raw material, the cost of obtaining it is high.

In the U.S., board plant locations reflect the need for proximity to raw materials and the desire to be as close to the market as possible. Particleboard plants, whose operations are so closely associated with residue material, are heavily concentrated in the areas of primary lumber and plywood production in the western and southern states. But particleboard is somewhat freer of species limitations than lumber and plywood, and can be and sometimes is made of low

density hardwoods as well as softwoods. Thus particleboard plants are also found in North Central and Northeastern states, far from the great coniferous forestlands of the South and West. Of course, plants located in these northern areas also have access to local softwood species.

Future Price Range for Industrial Particleboard

Comments made in the waferboard section, that the price "forecasts" are intended as a basis for discussion only, in view of the many obstacles to long range price forecasting (or short range, for that matter) apply here.

All costs included in manufacturing particleboard will rise, due to inflation, thus raising the floor price below which plants cannot operate. However, the industry should still be subject to wide price swings depending on transient economic conditions.

LGA projects mill prices in 2000 to range between $400 and $490 per M sq. ft. 3/4", or $445 $\pm$ $45, or about 10 percent.

Volume Markets Potentially Available to the Dead Softwood Region

Industrial particleboard plants in the West and Inland regions now ship to all parts of the U.S. but most of their production is sold as close to home as possible. The likely market available to a new Inland Region industrial particleboard plant would be about 6 percent of the total, or about 13 million sq. ft. 3/4" currently and 18 million in 2000. The Mountain states are not significant producers of furniture or cabinetry, nor are they likely to be.

The entire area west of the Mississippi includes a number of significant centers of furniture and cabinetry production, as enumerated earlier. This area in turn consumes about 18 percent of industrial particleboards, or 400 million sq. ft. 3/4" currently, growing to 540 million in 2000.

HARDBOARD

BACKGROUND

In the United States, hardboard was the first of the reconstituted panel products. Hardboard was developed in 1924 by William H. Mason, who had previously observed that wood chips could be "exploded" with high-pressure steam, creating wood fibers. Mason used a steam heated press to dry the fibers and accidentally left them too long under the heat and pressure. The resulting material was the first piece of hardboard. Following this fortuitous discovery, the hardboard industry's first plant opened in 1926.

Hardboard operations are able to use practically any form of wood for raw material. Wood pieces and/or residues are sent first to the fiberizing process. After the material is reduced to a fiber, it can be laid up into a mat with either a wet or dry forming process. The formed mat is then ready for compression in a large hot press. After the pressing and any necessary humidification period, the large panels are cut to size for their subsequent end use.

The terms wet-wet, wet-dry, and dry-dry describe the alternate forming methods. The terms smooth one side (S1S) and smooth two sides (S2S) describe the surface finish of the board as it comes from the press.

Wet-wet processing involves forming the board with excess moisture on an endless wire, removing water via drainage and vacuum, and then sending the high-moisture content mat to pressing. It is formed wet and pressed wet as in making paper. In pressing, the board is pressed between steel plates, with a wire screen on one side to allow for the water/steam to escape during the pressing/heating cycle. The panel pressed between plate and wire is referred to as S1S (screen back) board. Adhesion occurs as the heat and pressure cause the natural wood lignins to flow.

In wet-dry processing, the mat is formed as in wet-wet processing, however, it is dried before it is pressed. Thus the board can be pressed between smooth plates to make S2S products. Pressing in this process can also be accomplished with a screen back if this kind of board is desired.

Dry-dry processing involves the felting of dry fibers on a steel plate or caul and moving the dry mat to the press for either S1S or S2S production. Because heat and pressure do not reach the levels of wet processing, resins must be added to provide bonding.

The densities of the finished product generally range from 40 to 70 pounds per cubic foot. The product is manufactured in thicknesses of 1/8" to more than ½" in sheets as large as 5' x 18'. End uses usually define the thickness required. For example, 1/8" board is commonly the base for tile board, ¼" is often prefinished for interior wall paneling or sold into a host of industrial and furniture applications, 7/16" is most frequently used as exterior residential siding.

Hardboard is dense, uniform, usually smooth surfaced, can be worked with ordinary woodworking tools, takes finishes well, can be bent to a curvature, and can be punched or die-cut. The material can be embossed or scored during the pressing operation to simulate various surface textures. Hardboard can also be tempered by impregnating the pressed boards, with oils and/or resins, and then heat treating. This treatment increases the strength and water resistance above that of untempered hardboard, and generally increases the density. An S2S finish can be achieved with screen back board by laminating two thin S1S boards together or by sanding the back of a high quality S1S product. Another oft-used finishing operation is to perforate the board to produce a pegboard material for store display, garage liner and similar applications.

Domestic hardboard production grew from 2.4 billion sq. ft. 1/8" in 1962 to about 7.8 billion sq. ft. in 1978, which reflects a relatively consistent growth, at an annual percentage increase of about 7.6 percent in recent years. Table 32 shows shipments from 1951 to 1978. The growth has not always been a consistent annual incremental increase. Poor furniture markets, combined with lower residential housing starts stopped hardboard growth in 1974 and 1975.

In hardboard markets, imported boards have played a significant role in the total U.S. supply since the early 1960's. Imports have in most years supplied about 10

Table 32

U.S. HARDBOARD SHIPMENTS, IMPORTS, AND APPARENT CONSUMPTION

(Millions square feet - 1/8" basis)

	U.S. MILL SHIPMENTS	IMPORTS	APPARENT U.S. CONSUMPTION	IMPORTS AS A PERCENT OF CONSUMPTION
1951	823	56	879	6.4
1955	1,456	106	1,570	6.8
1960	1,870	235	2,150	10.9
1961	2,039	267	2,306	11.6
1962	2,426	342	2,768	12.4
1963	2,432	432	2,864	15.1
1964	2,689	471	3,160	14.9
1965	2,921	572	3,493	16.4
1966	3,083	443	3,526	12.6
1967	3,083	426	3,464	12.3
1968	3,710	648	4,358	14.9
1969	4,247	708	4,955	14.3
1970	4,384	457	4,841	9.4
1971	5,225	634	5,859	10.8
1972	5,798	1,070	6,868	15.6
1973	6,050	1,039	7,089	14.7
1974	5,654	750	6,404	11.7
1975	5,681	277	5,958	4.6
1976	6,485	494	6,979	7.1
1977	7,714	627	8,341	7.5
1978	7,800	919	8,719	10.5

SOURCE: American Hardboard Association

percent of domestic consumption falling to a little below five percent in the poor year of 1975, but in some years providing up to 15 percent of U.S. consumption. The imported board is brought into this country from Mexico, Canada, South America, South Africa, Australia, New Zealand, Poland, and the Scandinavian countries. Unfinished raw (brown board) panels are the usual import products.

Prior to 1945, only two plants were in operation in the United States, both in Mississippi, one operated by the U.S. Gypsum Company, and the original Masonite plant at Laurel, Mississippi. In each succeeding decade, about 10 new plants have been added, along with capacity increases at older plants.

The older plants utilize mainly the wet process. Of the 12 plants built prior to 1955, five were of the wet-wet type, five were wet-dry, and the remaining two employ the dry process. The last wet process plant was completed in 1967. Expanding plants do not necessarily retain the same process already in use at that location; several plant sites have more than one process in operation.

While the oldest plant in the industry, the Masonite facility at Laurel, Mississippi, is also the largest, this is the exception rather than the rule, as the older plants tend to be smaller plants.

Currently, there are 27 plants in the United States (none in Alaska or Hawaii). These plants are in all regions of the country (See Table 33).

Table 33

HARDBOARD PLANTS IN THE U.S.

REGION	NUMBER OF PLANTS	RATED CAPACITY (Million sq. ft. 1/8")	PERCENT OF CAPACITY
Northeast	1	500	7
North Central	6	1,695	23
South	11	3,535	49
West	9	1,555	21
	27	7,285	100

The relatively large Masonite plant in Pennsylvania is the only plant in the Northeast region, with about 7 percent of the nation's total capacity. The six plants in the North Central region have about 23 percent of industry domestic capacity while the eleven southern plants account for about 49 percent. The nine western plants are individually smaller and account for only 21 percent of the capacity. The diversity of the plants across the country illustrates that hardboard can be made from a wide variety of species, as well as with variations in the size of the raw material ranging from whole logs to sawmill residues. Also note that the nation's rated production capacity is smaller than hardboard consumption in 1978. This has been the traditional position of the industry as imports have long played a significant role in supplying the domestic hardboard demand.

These 27 U.S. plants are owned and operated by 14 companies. Only 6 companies operate single plants. The majority of hardboard companies operate two or more plants. (See Table 34). The Masonite organization is the dominant domestic manufacturers, with three plants located coast to coast, producing over a third of the hardboard in the United States. The next three major hardboard producers, each with just under 10 percent of the nation's output, are Superwood, Boise, and Abitibi. Weyerhaeuser, Georgia-Pacific, Champion, and U.S. Gypsum round out the remainder of the multi-plant producers.

U.S. Gypsum is the second oldest producer and started its Greenville, Mississippi plant in 1934. Georgia-Pacific operates two major plants, one on each coast, while Weyerhaeuser operates plants on both coasts and one in Oklahoma. Champion Building Products (formerly U.S. Plywood) is also one of the early hardboard producers; like U.S. Gypsum, it has not expanded activities in recent years. Evans Products used to operate four plants, but sold off two hardboard and one MDF plant, a few years ago, when they had a severe cash flow problem. Evans is now operating a single plant in Oregon.

Table 34

U.S. HARDBOARD PRODUCERS

COMPANY	NUMBER OF PLANTS	TOTAL CAPACITY (Million sq. ft., 1/8")	PERCENT OF U.S. TOTAL TOTAL CAPACITY
Masonite	3	2,725	37
Superwood	3	630	9
Boise	2	620	9
Abitibi	2	595	8
Weyerhaeuser	3	530	7
Georgia-Pacific	2	465	6
Champion	3	440	6
Temple	1	265	4
Celotex	1	240	3
Superior Fiber	1	140	2
Evans	1	110	2
Stimson	1	100	1
Publishers	1	40	--
		7,385	100

MARKETS AND MARKETING

Industrial Applications

The earliest products of the industry were thin, dense panels, usually from 1/8" to 1/4" thick, and this type of unfinished product is referred to as brown board. Brown board was initially sold to industrial concerns but today, less than a third of hardboard produced moves as brown board into these traditional markets. Currently two-thirds of the output is finished into tileboards, interior wall paneling, and exterior siding. The furniture industry remains an important outlet for hardboard, as millions of square feet are annually cut-to-size and used as drawer bottoms, case backs, drawer separators, shelf dividers, sliding doors, mirror backs, etc.

Two other examples indicate how hardboard is and has been incorporated into furniture and cabinetry production for a score of years. First, a panel is used as the top surface in what is called a drum table top. This assembly is also often used to make the end panels for cabinets. In the drum-type sub-assembly a frame of hardwood lumber is assembled and the hardboard is applied as a skin over the top of the frame. The assembled piece costs less than would a solid lumber panel. A second illustration of the use of hardboard is as a center-recessed panel in a cabinet door. Here, the exterior frame, again usually of hardwood lumber is milled and assembled and the hardboard insert is applied from the back side to create a door with a recessed appearance.

Hardboards are commonly finished into blackboards. When perforated into pegboards they are commonly incorporated into fixtures. Hardboards can also be die-stamped, to create decorative panels for many applications. Significant volumes of cut-to-size hardboards are used in making clipboards, toys and games, luggage, signs, and trays. As a non-conducting material, hardboards find applications in electrical apparatus, as separator plates, and circuit panels. Hardboards are also used by the automotive industry as battery separators, door linings, headliners, glove boxes, sunvisors and splashboards.

These industrial markets for hardboards are diverse and relatively mature. In many of these industrial applications hardboard competes with plastics and with thin particleboards and plywoods. In the latter case, hardboard is a common core material under real veneer when making a thin hardwood plywood. Brown board in total is relatively static, while domestic brownboard may even decline, under pressure from expanding world production and imports to the U.S.

Interior Paneling

About 1 billion sq. ft. 1/8" of hardboard is finished into interior panelings. There are two types of interior paneling, tileboard and wall paneling. Tileboard is the smaller volume, with about 150 million sq. ft. 1/8" annually. In contrast, wall paneling accounts for about 850 million sq. ft. 1/8".

Tileboard is a 1/8" thick product, almost always tempered to provide water resistant characteristics, and then finished with a high quality abrasion-resistant finish. Some tileboards are utilized in some new construction to provide a decorative yet tough and durable wall or partition, but most tileboard is utilized in the repair and remodeling aftermarkets in residential and commercial applications. In the do-it-yourself market, tileboards are assembled in kits, including metal extrusions for trim, and offered for tub enclosures. The tileboards face effective competition from the high-pressure melamine laminates such as Formica in many of their applications. Tileboards are less costly than high pressure melamines, particularly when the latter require backing. The repair and remodeling market is active and growing, but because of the competitive impact of high and medium pressure laminates and other plastic coatings, the tileboard segment of the hardboard industry does not share this growth.

Wall paneling hardboard uses some 1/8" material but more frequently is 3/16" or 1/4" thick. These panelings are infrequently used in new construction; the volume application is in the repair and remodeling aftermarket, both residential and non-residential construction. Whereas tileboards are specifically intended to withstand moisture such as tub enclosures in bathrooms, the normal interior

paneling is not expected to withstand exposure to continued moisture. Interior panelings are produced with wet print finishes as well as by laminating vinyl or other decorative sheets over the base hardboard.

The primary competition for hardboard as an interior paneling comes from the hardwood plywood industry. Currently the vast majority of hardwood plywood used as paneling is imported. The predominant face species is lauan which is laid up in Taiwan, Korea, Malaysia, and other Pacific area countries. The Japanese no longer supply significant quantities of hardwood plywoods to the United States, as they have been supplanted by the lower cost product coming from lesser-developed Pacific nations.

While some of the hardwood plywood that comes from Asia with a lauan face is stained or otherwise finished and sold as a prefinished lauan panel, much of the lauan plywoods are imported "in the white" and finished in this country to resemble oak, walnut, cherry, teak, and other more exotic species by printing or overlaying. A limited volume of high grade true species hardwood plywood paneling is still utilized in commercial and custom residential construction, but by and large the interior paneling markets are dominated by imported plywood. Further, wall paneling markets are well supplied, and have become rather stable. Alternate wall coverings including wallpapers and other decorative plastic materials are showing some resurgence in the repair and remodeling after-markets, at the expense of wood paneling. Hardboard wall paneling, particularly when high quality finish is applied to the dense surface, has superior abrasion and damage resistant qualities, compared to many hardwood plywood panelings.

Overall, the interior paneling market for hardboard is an important part of the market but it, too, is relatively stable with only modest growth likely.

Medium density (hardboard) siding

The major product from hardboard mills today is medium density siding, with a density about 40-44 lbs./cubic foot, which is produced in both lap and panel styles, by wet and dry process hardboard plants. The original hardboard sidings

in the early 1960's were denser, difficult to nail and finish, and generated low acceptance in the construction trades. Factory finishing (at least priming), and lowering the density of the product helped its acceptance by builders, particularly as medium density sidings were very competitively priced against lumber sidings which were still quite dominant in the 1960's.

Medium density sidings can be made in most hardboard plants, even though they do require some changes from producing brownboard. In addition, it is important that the production facility have the ability to at least prime and more likely to prefinish the siding to enjoy reasonable market acceptance. Therefore, while almost all ofthe hardboard plants can produce medium density siding and hence the capacity to produce siding with relatively modest capital investments is easily expanded, only about 15 of the hardboard plants are actively producing medium density sidings.

In the 1970's an increased variety of medium density sidings, including the textured and prefinished types, were introduced and met with great success. Based on a combination of attractive variety and appearance, competitive price and relatively easy handling, medium density siding production grew from about 475 million sq. ft. (1/8" basis) in 1960 to 4.7 billion sq. ft. (1/8" basis) in 1978 (See Table 35).

Table 35

PRODUCTION OF HARDBOARD MEDIUM DENSITY SIDINGS - 1960-1978
(Million square feet)
(Selected years)

Year	1/8" Basis	Surface Measure
1960	475	160
1965	680	230
1970	1,050	350
1972	2,300	725
1975	2,400	755
1977	4,400	1,260
1978	4,700	1,342

Table 36 lists the key industry producers.

Table 36

LEADING MDS PRODUCERS - 1978

COMPANY	NUMBER OF PLANTS PRODUCING SIDING	VOLUME (Million sq. ft. 1/8")
Masonite	3	2,000
Weyerhaeuser	3	530
Boise	1	450
Abitibi	2	400
Georgia-Pacific	1	300
Champion	1	300
Celotex	1	240
Temple-Eastern	1	200
Others	2	280
TOTAL		4,700

It should be emphasized that the production of medium density siding requires a broad array of patterns to be effective in the marketplace. Mills must maintain a high inventory of finished and semi-finished goods, covering all of the various patterns and stages of finishing. The production of an adequate range of siding patterns, colors, and finishes requires twice the level of operating personnel and several times the floor space to finish and ship the sidings than are required in the core production area to make the siding blanks.

Sidings are usually 7/16" thick, although some 3/8" and 1/2" thicknesses are produced as both panel and lap sidings. Panels are somewhat more popular today, accounting for 60 percent of production, and are used in both multi-family and single-family housing, while lap siding is usually restricted to single-family housing. Panel sidings are 4' wide invariably, with lengths of 8' and 9' required, and 10' also quite desireable.Lap siding is most often 16' although other lengths are available.

Sidings were initially simply primed and painted, presenting a smooth surface. However, the enormous popularity of textured appearances found a ready response in hardboard sidings. Smooth surfaces may be grained, or grooved to simulate reverse board and batten or other patterns. Texturing is incorporated into panels during the pressing.

The overall demand for prefinished varies sharply by city and region, depending upon (1) rules governing local labor in regard to whether carpenters may apply prefinished materials without follow-up work by painting crews, and (2) the costs of using painters in the local area. There is a greater demand for prefinished in the metropolitan areas, where union painters dominate the scene, than in rural areas where less costly labor is available for field painting.

Competitive Position of MDS

The selection of siding is influenced by such criteria as codes, insurance, and other regulatory factors, the kind of structure and the type of builder. For those builders who are constructing units which will be sold or managed by someone other than the builder, low applied costs and ready availability of materials are more important than either the appearance or lower maintenance costs over the life of the building. Other multi-family units are built with the owner and the future manager involved in the construction process. Low future maintenance costs and a continued good appearance of the structure are prime criteria; lowest applied costs and immediate availability of materials are secondary.

In single family construction, volume builders are most influenced by the applied first costs of the siding. Appearance, variety, availability, and maintenance cost

are of secondary importance. Custom builders, erecting only a few units, which are usually higher priced, and with the frequent involvement of the owner in the selection process, are more interested in appearance and the quality or reputation of a specific siding. Applied costs and low maintenance costs are of lesser interest.

Single-family builders use more hardboard than any other siding; the low applied cost, particularly among volume builders, is a dominant consideration. Naturally, there is a tendency for more expensive homes to use more expensive claddings, e.g., rarely will a low-cost home utilize any brick. In contrast, stucco is used on lower-cost homes in the Southwest. The total cost of the home is not an absolute guide to the choice of a cladding price range, however, as there are many tradeoffs in the overall price of the house. Some buyers and builders prefer larger rooms, better appliances, etc. to an expensive (brick, stone, bevel lumber) siding.

In commercial construction, the selection criteria relate first to appearance, second to low maintenance, and third to applied costs. Commercial construction is, of course, more rigidly controlled by code and other regulatory requirements which affect the exterior sidings which usually must be fire resistant, and thus offer little potential for wood board products.

The architect is a moderately important influence in material specifications for multi-family and commercial construction. He is of limited influence in single family building. Large volume single-family builders usually have in-house design staff rather than utilizing an outside architectural firm.

Industrialized housing consists of a few successful modular home builders and suppliers of pre-cut packages, and the larger portion of residential construction that is field assembled using factory built wall, roof, and floor sections or other components. Several firms including Kingsway (Boise), Capp (Evans), and Jim Walters (Jim Walters Corporation) are owned by organizations that produce hardboard or other siding and are predisposed to their use.

The outcome of these various criteria and practices has been that MDS has recently grown to be the largest factor in wood residential siding, with softwood plywood just behind. MDS is used primarily in single family housing, and has a smaller place in multi-family dwellings. MDS has about a third of the total of the new residential non-masonry siding market, with plywood not far behind, accounting for about a fourth of that total. While there is no reason to expect continued major displacement of softwood plywood, MDS usage will certainly grow.

In the residing market, only relatively small volumes of MDS are currently used. This is because additional siding is often chosen to match the original, which is most often another material. For residing when all the siding is replaced or recovered, no material can so far match the business system developed by aluminum siding manufacturers over the years. While other sidings may enter this market, successful ones will probably be like vinyl siding which lends itself to the same system, rather than MDS. No substantial growth for MDS is seen here, but some growth can be expected as the market itself grows.

The competitive position of medium density siding in the single family residential market is strong, based on lower applied costs (See Table 37). There is very little labor difference between applying hardboards and/or plywood panels, and the material costs for primed medium density siding are a bit below the lower or rustic grades of plywood sidings. The redwood and western red cedar plywood sidings are considerably more expensive than the primed panels and in some cases, more expensive than the prefinished medium density sidings. The comparative costs to the builder for a finished wall of plywood or MDS favors the hardboard product.

Similarly, medium density siding is currently lower in applied cost than the prefinished aluminum sidings, and obviously far below brick. The vinyls have moved into the market slightly in the last few years, in a manner paralleling aluminum even though costs of the vinyls are a little more than the aluminum siding. Lumber sidings are more expensive to apply than hardboard lap siding in that the random lengths of the lumber pieces requires more on-site labor. Also, the material cost for the siding lumber even when common boards are used as in board & batten, are higher than the medium density siding materials.

Table 37

APPLIED COSTS OF EXTERIOR CLADDINGS PER SQUARE [1]

($ per square)

Product	DIRECT LABOR[2]	MATERIALS COSTS[3]	TOTAL COSTS
Plywood Panels (ex. Redwood)	$ 31-36	$ 36-61	$ 67-97
(Redwood face)	31-36	47-95	78-131
Hardboard (primed panels)	32-34	36-43	68-82
(prefinished panels)	32-34	50-63	82-97
Hardboard (lap primed)	33-37	34-48	67-85
(prefinished lap)	33-39	48-63	81-102
Aluminum (prefinished)	40-50	40-70	80-120
Brick	216-286	87-120[4]	303-406
Lumber (bevel siding) unfinished	40-44	62-104	102-148
(board and batten)	47-53	50-108	97-161
Vinyl (prefinished)	35-39	76-80	111-119

(1) Does not include any painting or staining materials or labor, except when siding was prefinished.

(2) Does not include supervision.

(3) Lumber and plywood higher in the Eastern areas due to transportation costs.

(4) Brick higher in the Northern and Eastern areas due to transportation costs.

SOURCE : National Construction Estimator, 1978

From an appearance point of view it is quite difficult to tell the various types of sidings apart once they are applied and finished with paints or stains. The predominant color of prefinished aluminum siding is white, as is true with several of the wood products. The latter are also finished with natural stains which provide a unique appearance. This type of finishing has certain physical advantages and provides the opportunity for premium prices for the natural wood sidings.

The higher volume sidings are still the lower-cost ones and it is in this area that the bulk of the medium density fiberboard sidings have shown their greatest gains. Some of the specialty medium density sidings are prefinished to resemble stucco, or brick or other exotic patterns; these are used to a minor degree, primarily as accents.

In summary, the characteristics of the medium density siding market appear to be remaining intact and it is probable that this type of siding will continue to grow in acceptance.

DISTRIBUTION

(1) Industrial Board

The key factor in moving hardboard from the production mill to the industrial user is the cutting and other fabricating of the basic panel product as it comes off the large presses into a component to be utilized in the furniture or other industrial plant. These industrial plants are assemblers; usually only part of the product is made of hardboard and the plant is not prepared to fabricate it. For the hardboard producer there are two methods of moving panels from the mill to the industrial markets. The first is to operate, either at the plant site or at least nearby, a cut-to-size and fabricating department that is attuned to supplying on a regular and scheduled basis, job lot quantities of the wide variety of components and sizes needed by the industrial user. The second approach is to sell basic stock size panels to independent fabricating facilities, including hardwood plywood manufacturing plants, who in turn make a component saleable to the furniture or other industrial concerns.

Sales of brown board are achieved by selling direct to industrial accounts, or to fabricators who cut, machine, or finish the panels. Some hardboard is sold as a utility panel in construction; for example, one use is as underlayment in floor remodeling. This market is supplied through traditional building materials channels, that is, from mill to stocking wholesalers (which may be company owned branches) who resell to dealers who supply contractors or consumers.

(2) Wall Paneling

Finished wall paneling is produced by hardboard mills or by finishers who buy direct from mills. Paneling is sold to stocking wholesalers who then supply general line or specialty retailers in the paneling field. Some of the largest retail chains buy direct from mills or finishers, although this is ambiguous, since such large purchasers have established wholesale buying functions. The retailer then supplies contractors and the DIY trade.

(3) Sidings

Masonite is not only the leading U.S. producer of hardboards, but also of siding products, and has been a leader in the development of prefinished sidings. Masonite differs from many producers of reconstituted and plywood panel products, in that it does not utilize any captive distribution to market its products. It markets its siding products through independent wholesale firms who sell to retailers or in some cases to general or siding contractors. Other significant medium density siding producers such as Abitibi and Celotex also utilize this approach. Conversely, Georgia-Pacific, Weyerhaeuser, Boise, and Champion Building Products, all major producers of medium density siding, do have their own captive distribution facilities to reach the market.

PRICING STRUCTURE

The overall availability of hardboard mill capacity and the influx of imported hardboard in the light of a relatively mature industrial market tended to stabilize brown board prices through much of the 1960's and early 70's. During

1973, brownboard prices began to move upward, in part reflecting a modest increase in demand for brown boards as the nations population and demand for the products of the industrial customers continued to grow. By late 1973, the available supply of brown board was lower; some hardboard mills had switched production into the more profitable items of siding, less brown board was available to the industrial users and brownboard prices went up. Brownboard prices dipped quite severely in the 1974-75 recessionary period but recovered rather sharply in 1977. Currently, brownboard prices are down a bit from their peak in 1978, and should the current business slowdown seriously affect the furniture industry, undoubtedly will continue to drift downward until the recession is resolved (See Figure 14.)

Actual brownboard prices are not published in any industry source. As obtained from the Bureau of Labor Statistics, the 1978 average was about $93.37 per thousand sq. ft., 1/8".

The major reason for the difficulty in establishing hardboard prices of any type is that hardboard is sold on a delivered basis. Thus mill realization is the net of freight. This is shown in Table 38, which illustrates this point in the pricing of MDS siding. These prices are gross, delivered to large buyers (wholesalers) who pay less a standard discount, often 8 percent. They then resell at the published prices.

Figure 14

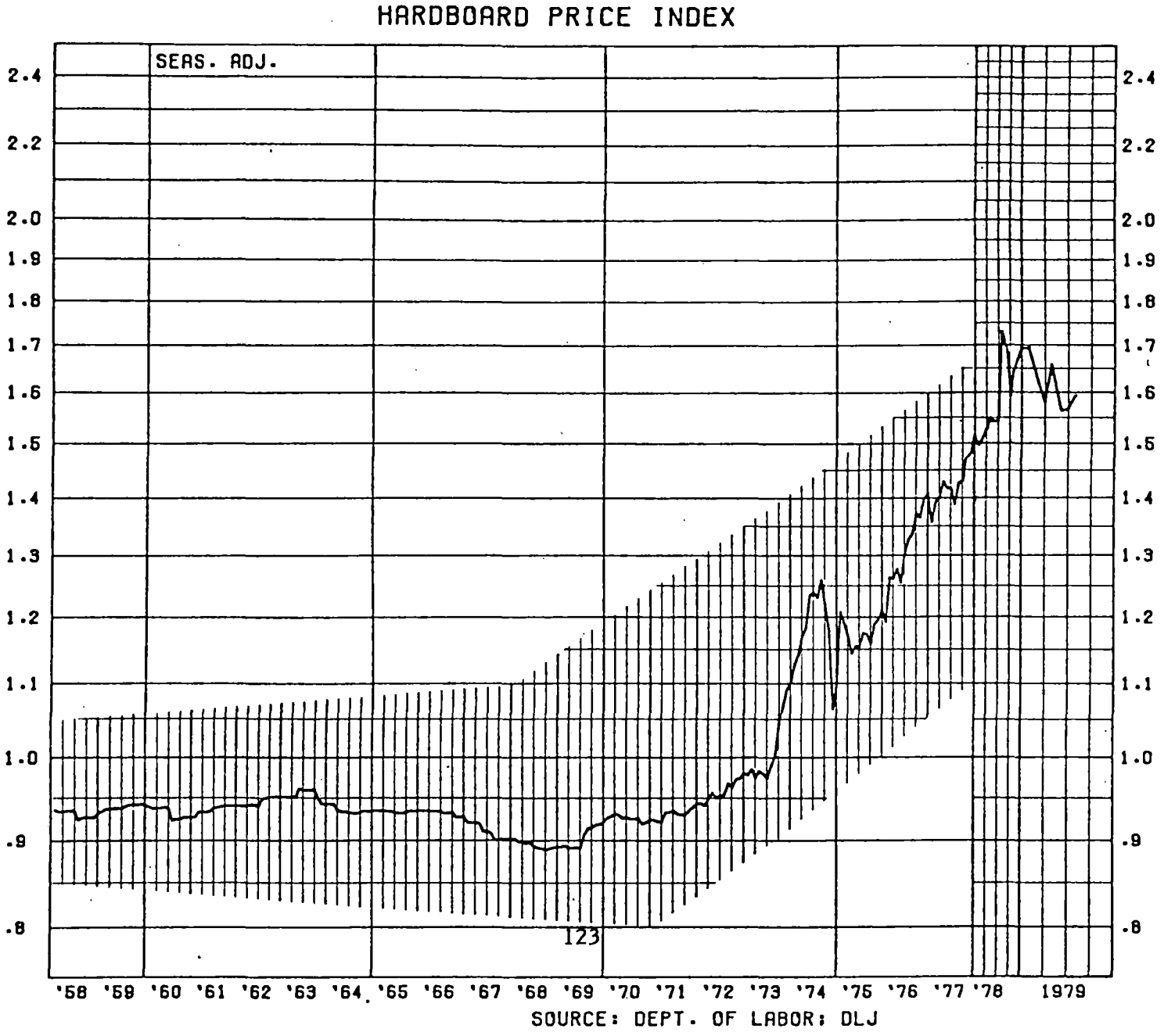

HARDBOARD PRICE INDEX
SEAS. ADJ.
2.4
2.2
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
.9
.8
123
'58 '59 '60 '61 '62 '63 '64 '65 '66 '67 '68 '69 '70 '71 '72 '73 '74 '75 '76 '77 '78 1979
SOURCE: DEPT. OF LABOR; DLJ

Table 38

CURRENT DELIVERED PRICES/M FOR CARLOAD BUYERS

PRODUCT	Destinations						
	Portland	Denver	Minneapolis	Dallas	Chicago	Newark	Atlanta
Smooth Lap 7/16" Hardboard	$ 205	$ 205	$ 205	$ 205	$ 205	$ 205	$ 205
4' x 9' Textured 7/16" Panel	275	275	275	275	275	275	275

REQUIREMENTS FOR COMPETITIVE MARKETING OF DEAD SOFTWOOD HARDBOARD PRODUCTS

The basic requirements for brown board are that a product be made comparable to those readily obtainable from the 29 existing facilities plus the many foreign countries which export to the U.S. Product should be available in 4 x 8 panels, in thicknesses including 1/8", 3/16", 1/4" and 5/16". Thicker panels in hardboard are rarely required; the weight is excessive for most uses so that other products are employed. Conversely, there is a market for thinner panels, e.g. 1/10" for doorskins. Finally, it is desireable to have both S1S and S2S available, although this is not likely to be a problem. New plants are likely to be dry process, which automatically generates S2S.

For wall paneling and similar specialties requirements exist over and above those for brown board. The most important is for good printing, embossing/distressing, and coating equipment, that can produce woodgrain and other patterns acceptable to the trade and consumers. These must be of a high quality level since the field has become quite sophisticated and it is increasingly difficult to distinguish hardboard paneling from hardwood plywood. The distribution system is also considerably more complex, in that paneling is not sold direct, as is industrial board, but through stocking wholesalers. Since hardboard paneling is not a growth market, distributors now handling other paneling lines must be enticed either away from their present suppliers or to entertain a second line of product.

Siding is yet again a higher level of complexity. Basic primed lap and panel siding comprise a decreasingly small part of the mix. Specialties with various prefinished and grainings comprise the larger portion of sidings. It is also necessary to have a 16' press in order to make lap siding which is almost half of the siding output. Significant investments in space and inventory are required for sidings. As with paneling, distribution is through wholesalers, so that a stocking wholesaler network must be developed using most if not exactly the same firms now handling the output of the present 15 siding producers.

Based on the technical assessments conducted by Washington State University and discussed before, there is no reason to believe that fully acceptable hardboard products could not be made from a furnish consisting of dead softwood, all or in part.

ADVANTAGES AND DISADVANTAGES OF PRODUCTION IN THE INLAND REGION

There is now one hardboard plant operating in the dead softwood area of Oregon; there are 11 in the West, mostly in Oregon, and 6 in the North Central region, mostly in Wisconsin and Minnesota. Since there are hardboard plants in every major section of the country, hardboard sales tend to be localized about a given plant. This is reinforced by the fact that hardboard is sold delivered, so that as market distance from a given plant increases, freight absorbed also increases, reducing mill return. Single plant companies tend to look for close-in markets for all except the highest priced specialties.

Thus, there are no advantages to a hardboard plant in the dead softwood region since the markets available in the sparsely populated areas tend to be small. Of the 3 billion sq. ft. 1/8" of industrial board consumed in the U.S., LGA estimates that no more than 50 million sq. ft. or less than 2 percent is consumed in the Mountain states. The balance is consumed in the large industrial centers for furniture, automobiles, doors, and other consuming industries.

Of the one billion sq. ft. wall paneling market, about 5 percent of the U.S. consumption, or about 50 million sq. ft. is similarly consumed.

Of the 4.7 billion sq. ft. siding market, LGA estimates that about 8 percent or 380 million sq. ft. are consumed in all the Mountain states, mostly Colorado and Utah. If all three markets were to be fully obtainable two new facilities of average size would be required, which seem impractical in light of the many existing facilities on the fringes of the dead softwood area.

A mill in the dead softwood sectors of the Inland Region would have a freight advantage to only a small portion of the small Inland market described above, and that is likely to be only a few dollars per M, depending on location. LGA judges this to be of no particular advantage except perhaps in a minimal volume of the commodity brown board or wall panelings.

Tables 39-44 detail freight charges for siding from various potential mill sites to key markets. Denver provides the lowest overall set of freight charges to the selected locations in other parts of the U.S., although, in view of competition, it is unlikely that siding from any single mill can travel more than 1,000 miles on a cost effective basis.

TABLE 39

CARLOAD RATES APPLYING ON SIDING

From Boise, Idaho

effective 10/15/79

TO:	Carload Rates in cents per 100 Pounds (CWT)			Carload Rates in $ Per M Sq. Ft. S. M.
Chicago, IL	323 85,000#	294 (A)	285 (B)	45.22
Houston, TX	322 85,000#	293 (A)	284 (B)	45.08
Jasper, IN	368 85,000#	299 Excess	-	51.52
Kansas City, MO	291 85,000#	262 (A)	251 (B)	40.74
Los Angeles, CA	207 70,000#	-	-	28.98
Minneapolis, MN	291 85,000#	262 (A)	251 (B)	40.74
Winston-Salem, NC	388 70,000#	-	-	54.32

(A) Applies on excess weight on shipments not exceeding 119,999#

(B) Applies on excess weight on shipments weighing 120,000# or more

TABLE 40

CARLOAD RATES APPLYING ON SIDING

From Chester, California

effective 10/15/79

TO:	Carload Rates in cents per 100 Pounds (CWT)			Carload Rates in $ Per M Sq. Ft. S. M.
Chicago, IL	327 85,000#	299 (A)	290 (B)	45.78
Houston, TX	297 85,000#	267 (A)	258 (B)	41.58
Jasper, IN	374 85,000#	309 Excess	-	52.36
Kansas City, MO	297 85,000#	267 (A)	258 (B)	41.58
Los Angeles, CA	109 85,000#	89 Excess	-	15.26
Minneapolis, MN	314 85,000#	284 (A)	274 (B)	43.96
Winston-Salem, NC	388 70,000#	-	-	54.32

(A) Applies on excess weight on shipments not exceeding 119,999#

(B) Applies on excess weight on shipments weighing 120,000# or more

TABLE 41

CARLOAD RATES APPLYING ON SIDING

From Denver, Colorado

effective 10/15/79

TO:	Carload Rates in cents per 100 Pounds (CWT)	Carload Rates in $ Per M Sq. Ft. S. M.
Chicago, IL	196 / 70,000#	27.44
Houston, TX	243 / 60,000# 151 Excess	34.02
Jasper, IN	340 / 40,000#	47.60
Kansas City, MO	135 / 70,000#	18.90
Los Angeles, CA	322 / 75,000#	45.08
Minneapolis, MN	184 / 70,000#	25.76
Winston-Salem, NC	292 / 50,000# 192 Excess	40.88

TABLE 42

CARLOAD RATES APPLYING ON SIDING

From LaGrande, Oregon

effective 10/15/79

TO:	Carload Rates in cents per 100 Pounds (CWT)	Carload Rates in $ Per M Sq. Ft. S. M.
Chicago, IL	327 / 85,000# 299 (A) 290 (B)	45.78
Houston, TX	322 / 85,000# 293 (A) 284 (B)	45.08
Jasper, IN	373 / 85,000# 307 Excess -	52.22
Kansas City, MO	297 / 85,000# 267 (A) 258 (B)	41.58
Los Angeles, CA	145 / 85,000# 125 Excess -	20.30
Minneapolis, MN	297 / 85,000# 267 (A) 258 (B)	41.58
Winston-Salem, NC	388 / 70,000# - -	54.32

(A) Applies on excess weight on shipments not exceeding 119,999#

(B) Applies on excess weight on shipments weighing 120,000# or more

TABLE 43

CARLOAD RATES APPLYING ON SIDING

From Missoula, Montana

effective 10/15/79

TO:	Carload Rates in cents per 100 Pounds (CWT)			Carload Rates in $ Per M Sq. Ft. S. M.
Chicago, IL	323 85,000#	294 (A)	285 (B)	45.22
Houston, TX	322 85,000#	293 (A)	284 (B)	45.08
Jasper, IN	355 85,000#	290 Excess	-	49.70
Kansas City, MO	291 85,000#	262 (A)	251 (B)	40.74
Los Angeles	231 85,000	211 Excess	-	32.34
Minneapolis, MN	291 85,000#	262 (A)	251 (B)	40.74
Winston-Salem, NC	388 70,000#	-	-	54.32

(A) Applies on excess weight on shipments not exceeding 119,999#

(B) Applies on excess weight on shipments weighing 120,000# or more

TABLE 44

CARLOAD RATES APPLYING ON SIDING

From Rapid City, South Dakota

effective 10/15/79

TO:	Carload Rates in cents per 100 Pounds (CWT)	Carload Rates in $ Per M Sq. Ft. S. M.
Chicago, IL	187 / 70,000#	26.18
Houston, TX	287 / 60,000# 188 Excess	40.18
Jasper, IN	340 / 40,000#	47.60
Kansas City, MO	161 / 70,000#	22.54
Los Angeles, CA	322 / 75,000#	45.08
Minneapolis, MN	129 / 70,000#	18.06
Winston-Salem, NC	284 / 50,000# 182 Excess	39.76

ALLOWABLE WOOD COST FOR AN INLAND MILL

This section is based solely on brown board since no other data are provided on the capital costs for finishing and other equipment to make wall paneling or siding.

Using data as before from the Washington State University report, the suggested capital cost for a mill using dead softwood is $25.75 million. This is actually a trifle less expensive than a mill using all greenwood in that chip preparation is a trifle less costly. Such a mill would produce 185 million sq. ft. 1/8" annually (daily output of 224 tons) using a 5 x 18, 24 opening press. LGA notes that, when producing wall paneling, such a press would be operating at 20 percent less than capacity. Nor could such a press produce panel siding, without being stopped down to 4'.

The operating costs for this plant, including depreciation but not sales cost or ROI (same basis as used before) amounts to $35.21 per M. To this LGA would add $4.67 for sales cost (5 percent of $93.37) and $22.27 for a 30 percent ROI pretax, for a total of $62.15 total cost, excluding wood.

Hardboard, as noted before, is sold on a delivered basis. LGA assumes that, to sell the output of the mill as brownboard, the mill would have to reach out up to 1,000 miles, since only a small amount could be sold closer to home for lack of industrial customers. Using an average rail freight charge of $2.50 per cwt, average freight costs then amount to $19.23. Using this freight as a basis for estimation, the mill net would be $74.14 ($93.37 minus $19.23). Thus, the allowable wood cost would be $11.99 per M, or $30.74 per O.D. ton, delivered at the mill.

MARKET VOLUME AND PROBABLE PRICE RANGE IN THE YEAR 2000

Each of three hardboard products must be considered separately.

Brown Board

LGA does not expect any appreciable increase in U.S. production of brown board. Consumption may rise at the rate of about ½ percent per year solely due to secular growth, since this is a mature product and unlikely to find many new applications. Thus, consumption would grow from about 3 billion sq. ft. 1/8" to 3.3 billion, at the outside. Even this growth is likely to be almost entirely supplied by imports. Imports, which equaled 919 million sq. ft. in 1978 are almost entirely brown board.

Estimating probable price range as a basis for discussion LGA believes that mill prices for brown board will rise to about $130 ± $10 per M, 1/8" This anticipates a somewhat slower price rise than for other reconstituted wood products, since inflationary cost pressures are less. That is, brown board uses less resin and is made in older, depreciated plants, when made via the wet process, and these wet process plants make up and will continue to make up a major portion of the supply.

LGA is well aware that since hardboard is sold delivered, the prices to hardboard customers are likely to rise out of proportion to mill receipts. However, since we lack any rational basis for forecasting freight, the use of mill prices, even on a grossly calculated basis is preferable.

LGA has no data on the manufacturing cost of wall paneling and so makes no projection of future selling prices.

Siding

Siding consumption, almost entirely a domestic product, is expected to increase somewhat. Its useage is primarily a function of housing starts, since only

minimal volumes enter the large aftermarket which is dominated by aluminum and vinyl, a situation not expected to change. Still, MDS is in a favorable position vis a vis softwood plywood, its major siding competitor. Softwood plywood is seriously affected by the decreasing availability of suitable faces of acceptable species, and the consequent increases in cost and thus selling prices. It is unlikely that the West can increase it supply of plywood siding, and will probably decrease. The South is limited in that softwood plywood species there are less desireable, and present plants can not procude the 9' and 10' panels desired. Of course, new presses and lathes can always be installed.

On balance, LGA expects that 1978's production of 4.7 billion sq. ft. 1/8" of sidings could well increase to 6 billion sq. ft. by 2000.

Since LGA has no data on the manufacturing costs of siding, we make no projection of future selling prices.

Potential Share to the Inland West

LGA expects that the share of the market currently existing for the three major hardboard products is likely to remain reasonably stable.

On this basis brownboard consumption in the Mountain states should be about 55 million sq. ft.; wall paneling about 75 million sq. ft. and siding about 500 million sq. ft., all 1/8" basis, in the year 2000.

This is an incremental total consumption of about 150 million sq.ft. 1/8" or less than one plant's additional capacity. This also ignores the probablity that some of this demand, although a small amount, will be satisfied by imports.

Rather than a new plant, it is more likely in LGA's view that this slowly growing market (except for siding) will be slowly satisfied by expansion of existing plants at the existing locations. This is also true for siding, but new siding plants, if any, are likely to be built as close as possible to major population and housing construction centers. Since most population growth is occurring in the South and the coastal West, and since there is wood fibre available in many parts of these broad regions, LGA believes that any new plants will be built there.

MEDIUM DENSITY FIBERBOARD

BACKGROUND

MDF is a premium product which has more or less fortuitously found its present major markets. The concept originated almost two decades ago in the attempts by Messrs. Emerson and Brooks to utilize waste sulphite liquor as a binder in the manufacture of particleboard, in a pilot plant at Jackson, Mississippi. In this experimental process, it was found that fibers worked better than particles. The dry fiber process was named "Emerite," and two small plants were built using it. These failed due to binder difficulties.

The concept of using fiber was attractive enough to warrant further work, and in the early 1960's Brooks, in conjunction with Miller-Hofft Engineering and Allied Chemical, developed an alternate approach using fiber and a urea-formaldehyde binder manufactured by Allied Chemical. The original Allied-Miller-Hofft process was intended for the manufacture of 1" and thicker boards; in these thicknesses it was found that the use of an electrically heated (radio frequency, or RF) press (which also has steam-heated platens) gave better results than a conventional steam-heated press alone. At about the same time, Bauer Brothers of Springfield, Ohio, developed and commercialized their pressurized refining system to make fibers, which was a substantial improvement over the atmospheric refiners heretofore available. All of these several factors came together in the first true, successful dry process MDF plant, built in 1965, at Deposit, New York.

The product line was initially seen as a residential siding, but the product failed in this application, mostly because of the lack of water resistance and dimensional stability. The plant was then purchased from Allied Chemcial by Celotex Corporation (now Jim Walter Corporation) which abandoned the exterior products market and concentrated on the furniture corestock market. The new product was named Baraboard, and a substantial market development effort was mounted, based on its superior edge machining and face properties.

Baraboard had the field almost to itself for a number of years; most large producers of furniture corestocks, largely hardwood plywood and industrial particleboards at that time, ignored the new entry which was premium priced and available only in limited volumes. Two small plants were built in the latter 1960's, but both were captive to furniture companies (Kroehler and Bassett), and only a small percentage of the volume produced was marketed to other users. By 1970, a general appreciation of the premium properties of the product had developed, and a number of plants were built. A third wave of new plant entry occurred in the 1973-75 period, and the most recent plant was completed in 1979. This last plant was a conversion by Louisiana-Pacific of a former industrial particleboard plant at Eufala, Alabama. Table 45 shows the known MDF corestock plants and their capacities.

MDF actual production was at capacity during most of the early period of product development (1970 through 1974), but the ratio of production to capacity fell sharply in 1974-76 due to a severe, recession-caused fall-off in furniture and cabinetry manufacture, and to the introduction to the market of new plants, all within a short time.

Table 46 shows the historical rates of MDF production, compared to rated capacity, based on 4-shift, 300-day usage.

Figure 15 shows the location of the MDF plants and capacities by region in relationship to the furniture industry. It is interesting to note that more than a third of the capacity is in the West, where the wood is, but where markets are slim and cannot absorb the volume produced. Thus, western MDF must look to midwestern and eastern markets.

There are no plants in the North Central states, despite the heavy concentration of furniture and cabinetry production there, and only one plant in the Northeast, the original MDF plant at Deposit, New York. The Southeast has most of the capacity in a market which is the largest.

Table 45

MEDIUM DENSITY PLATEN* TYPE FIBERBOARD PLANTS, 1979

NAME	CAPACITY (MM sq. ft., 3/4")	REMARKS
Basset Furniture Company Bassett, Virginia	20	Mostly captive, but some market sales
Cellotex Corporation Deposit, New York	31	Original MDF board
Cellotex Corporation Marion, South Carolina	60	
Holly Hill Lumber Company Holly Hill, South Carolina	50	Many start-up and continuing production problems
Kroehler Furniture Meridian, Mississippi	18	All captive; low quality
Louisiana-Pacific Eufala, Alabama	90	Converted from an industrial particleboard plant
Louisiana-Pacific Rocklin, California	60	L-P committed to sell this plant acquired from Fiberboard Corp.
Masonite Corporation Spring Hope, North Carolina	75	Rebuilt in 1975; product name changed, quality upgraded
Medford Corporation Medford, Oregon	90	
Plum Creek Lumber Company Columbia Falls, Montana	70	
Weyerhaeuser Company Broken Bow, Oklahoma	65	Includes only 1 of the 3 fiber lines at this location
Weyerhaeuser Company Moncure, North Carolina	70	Former Evans plant
	699	

*Excludes Mende thinboard fiber-type plants.

Table 46

GROWTH OF THE MDF INDUSTRY

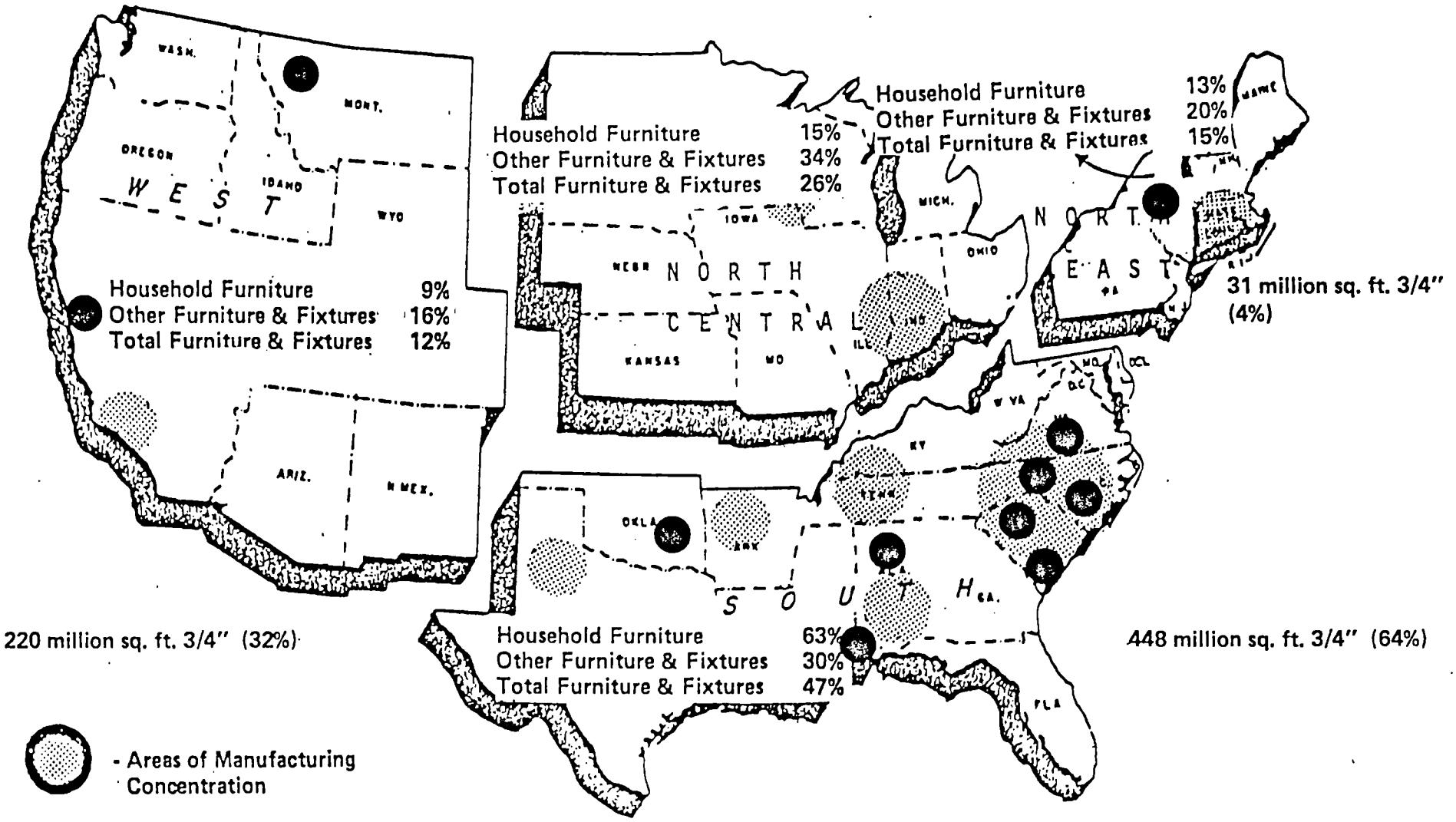
(Million sq. ft., 3/4")

Year	Production	Capacity
1971	Under 100	163
1972	163	230
1973	230	290
1974	250	290
1975	245	524
1976	280	609
1977	441	609
1978	508	609
1979 (est.)	550	699

SOURCE: LGA estimates 1971-75, 1979; National Particleboard Association, 1976-78.

Figure 15

LOCATION AND CAPACITIES OF MDF PLANTS, BY REGION, 1979, IN RELATION TO WOOD FURNITURE AND CABINETRY PRODUCTION


WEST
Household Furniture 9%
Other Furniture & Fixtures 16%
Total Furniture & Fixtures 12%
220 million sq. ft. 3/4" (32%)
NORTH CENTRAL
Household Furniture 15%
Other Furniture & Fixtures 34%
Total Furniture & Fixtures 26%
NORTH EAST
Household Furniture 13%
Other Furniture & Fixtures 20%
Total Furniture & Fixtures 15%
31 million sq. ft. 3/4" (4%)
SOUTH
Household Furniture 63%
Other Furniture & Fixtures 30%
Total Furniture & Fixtures 47%
448 million sq. ft. 3/4" (64%)
- Areas of Manufacturing Concentration

Total United States: 699 million sq. ft. 3/4"

MARKETS FOR MDF

MDF is used primarily in furniture and cabinetry of various types. However, a number of new and very promising applications are developing.

Furniture and Related Cabinetry

MDF using industries suffered sharp reverses in 1974-76, a trying period from which they recovered in the last two years. The history of the level of furniture production over the last two decades and the projection of our expectations is shown in the section dealing with particleboard.

But more happened during the recessionary period than simply a cut-back in buying. High-line producers were less affected; in fact, a number of firms operated uninterrupted throughout the recession and a few had the best performances in their history. These firms produced products made of high-grade materials, that is, fine veneer surfaces instead of prints or overlays, and solid lumber for many other parts, if not the whole top surface. Competition noted this, and a number of producers dropped their lower and low-middle lines, or concentrated on or redesigned a higher quality line, with good results.

Again, due to the slackening of volume demand, the price of all furniture wood-type raw materials dropped. There occured a sort of regression to practices of a decade ago, made desirable by the fact that higher-priced furniture still sold well, and made possible by the relative price drops of raw materials across the board. Thus, hardwood lumber dropped in price and rose in availability, which is much the same thing. So hardwood lumber was substituted for MDF. In its turn, MDF prices dropped, or at least discounting occured, and some industrial particleboard was replaced by MDF. In a sort of domino fashion, higher class materials, at least as seen by the very traditionally-minded furniture industry, replaced substitutes, reversing the process of the past decade.

This was a temporary situation. The supply of hardwoods, for example, had not increased, only demand had slackened. As demand for furniture, and consequent

demand for materials, increased, the industry returned to the material usage patterns of two years ago, and resumed the trend to man-made materials. However, this experience left its mark. Proportionate usage of reconstituted products has slowed, and that of hardwood lumber and veneers had increased. There is also a definite trend to better grades of furniture.

Prices, at least for some key raw materials, are noticeably on the rise. Hardwood lumber in more desirable furniture species rose steadily, and furniture manufacturers glumly expect this to continue. They expect to pay more and to look for substitutes, where feasible and acceptable. The obvious immediate substitution is MDF.

MDF is generally recognized as the optimum replacement material for hardwood lumber, if it is to be replaced. It is the panel material which is closest to being immediately factory utilizable as received, although no MDF is as good in production runs as the samples promise, in terms of clean O.G.* edge profiling, at factory speeds. Any MDF requires either slow machining, or after-filling, for top quality edges. But good MDFs are much better than conventional industrial particleboards in this regard.

Industrial users expect their MDF consumption to grow for a number of reasons: as a replacement for hardwood lumber; because furniture volume is growing; and as a replacement for five-layer construction using hardwood lumber edge-banded industrial particleboards and cross-bands (five ply is still used to a significant extent in this traditional industry). Most users expect to use a little more MDF each year, as furniture volume grows to the anticipated index level of 300 in 2000, as designs change, as hardwood lumber becomes more expensive, and as new suites are created. Of the 1978 production of 508 million sq. ft., 3/4", LGA judges that 70 percent, or 356 million, was consumed directly by furniture and furniture-type cabinetry producers.

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* A typical edge profile, somewhat S shaped.

Residential Construction

The only significant application for MDF deriving directly from construction is in high-middle kitchen cabinetry, used primarily in single-family dwellings and in the higher-ticket kitchen remodeling market. Top of the line cabinetry is still solid wood or hardwood plywood. Lower-middle and lower lines are usually particleboards, often vinyl covered or faced with a low-pressure laminate. MDF finds its place between these extremes. So far, only a small proportion of MDF is consumed in kitchen cabinetry and, conversely, only a very small proportion of kitchen cabinetry panel raw material is MDF. LGA estimates that about 15 percent of 1978's MDF production was used for kitchen cabinetry, or 76 million sq. ft., 3/4".

Other MDF Markets

MDF producers have not seriously sought other, non-furniture and cabinetry markets until quite recently. Most new entrants have concentrated on getting their plants on stream and in traditional markets. Each new entrant has looked to the same customer class as its predecessors, which, no doubt, has accounted for at least some of the industry's problems.

Exceptions are few. Prior to 1972, Pope & Talbot supplied Simpson Timber Company with a phenolic medium density hardboard used in panels for Simpson's colonial-style sash and panel doors. When, after a fire, P&T stopped making that product, Simpson unsuccessfully sought a successor and then gave up the line.

The Northwest is the center of the "stock panel" industry, which consists of about seven firms who purchase hardwood veneer (mostly birch, some oak) from the Northeast and Canada, and lay this up on 3/4" fir platforms, 4'x8'. These stock panels are then sold through stocking wholesalers to small cabinet and millwork shops, store display and fixture firms, etc. There has been a small but steadily growing penetration into this business by MDF, replacing the fir platform.

For the past few years, there has been some experimentation, but little use of MDF for moldings, casing, etc. This use has been hampered by the inattention

that MDF producers gave to the application; most developmental work was carried on by industrial users. Moreover, the lack of thick MDF for many moldings or turnings requiring larger than 4/4 raw material has been a handicap. But recently, spurred on by rising costs for shop pine and by the need to develop MDF markets, a number of molding firms have started to produce MDF moldings, as well as dowels and turnings and moldings.

Probably the largest of these additional uses in volume is for hollow core flush door stiles and rails, replacing shop lumber. Not all MDF plants can make the thicker stock required, since some are limited by the daylight in their press. For those that can, this is a promising and growing business.

Summing up all of these miscellaneous uses, LGA estimates that they currently account for about 15 percent of MDF consumption or, in 1978, about 76 million sq. ft., 3/4".

Applications

The applications of MDF encountered in furniture and cabinetry run the gamut of known uses: drawer fronts and other parts; doors; tops; sides; shelves; etc. Some of the newer uses include such parts as rails and fascia panels, which were traditionally of lumber.

Most MDF applications encountered call for 3/4" board and thinner. 5/8" and 11/16" are popular thicknesses for drawer fronts. There are applications for thicker boards, of course, 7/8", 1" and 1-1/8" for tops. However, applications exist for MDF in practically every feasible thickness from 1/4" through 1-1/8", by 1/16" increments, and that variation is simply due to individual company preference as much as anything. Different firms often use 4 or 5 different thicknesses for what is essentially the same application, as in drawer fronts for desks which are directly competing lines.

Furniture is by preference a cut-to-size (cts) market. Perhaps two-thirds of the MDF bought by furniture and cabinetry firms is cut-to-size as opposed to full

panel. But some MDF producers have no or limited or inadequate cut-to-size capabilities. Such producers must arrange (often awkwardly) for a fabricator to do the work. While many furniture firms require some panels for odd-lot work, the trend is continuing to get operations like cts out of the shop into the suppliers' plant, so that the furniture factory becomes more and more of an assembly plant.

MDF is often veneered reflecting the upgrading of furniture and the fall-off in lower-price lines. Print is now the largest volume man-made finish. There is some limited current use of low-pressure melamine or polyester overlay on MDF. There is a little use of vinyl films or high-pressure laminates, which are almost always laid up on particleboards, rather than the more costly MDF.

Distribution

The purchase of MDF, either for the first time or to supplement/replace another MDF, follows the time-honored caution of this traditional industry. If prices and delivery seem attractive, and samples are examined, then a test order of a few sheets is placed. If the material looks good in processing and/or the new suite sells, then a car or two (even three, for a large firm) is ordered. The final and ultimate test is on the factory floor.

MDF is sold direct, either to the using firm, or to fabricators who provide cut-to-size or finishing services and in turn sell to furniture and cabinetry shops. A small volume of material is sold through stocking wholesalers to the smaller user; these wholesalers are usually industrial specialists. MDF producers use their own sales staff primarily, but some use is made of agents and brokers.

Pricing Structure

MDF is a proprietary product and as such there are no prices published in trade or government publications. However prices must be reasonably competitive in the major sales areas, which are the Southeast, and the furniture concentrations in the Southwest and Central states. Since market prices must be competitive,

reflecting only some minor product differences and the differing reputations of the suppliers, it follows that mill prices must differ, since the several larger mills are at varying distances from market. Mill realizations for western suppliers are usually considerably lower than for mills located in the larger southeastern furniture zone.

In 1978 mill prices ranged from a high of $305 per M, 3/4", for a prominent mill in the Southeast to $237 per M for the mill on the West Coast located furthest from major markets. These prices are net of any discounts. Prices for MDF have risen substantially since the 1974-75 recession, when they averaged $75 per M lower than currently.

Requirements for Competitive Marketing of Dead Softwood Based Products

As with other reconstituted wood products, in order for a product from the dead softwood region to be competitive it must be equivalent in physical properties and supported by appropriate marketing functions. In a premium product such as MDF, quality is especially important.

LGA understands that a fully competitive MDF can be made from dead softwoods. Customer firms do not have sophisticated raw material quality control. Most have no lab facilities at all. While purchasing agents may discuss certain technical specifications with sellers, such as internal bond (I.B.) and surface smoothness, for the majority of buyers these terms have little, or only a general meaning. Buyers rely on sellers, and on practical tests: a knife in the center of the board; the appearance of resin spots; a dusty surface; what the foreman says after running some board.

Buyers think in terms of a good surface for gluing without delamination, of being able to shape an OG edge, not having warp or swell.

Important properties are as follows:

High I.B. so that the board does not split. 120 may be a usable average here, plus or minus no more than 20. 100 is a minimum. Top boards are 140 average, 130 minimum.

Surface smoothness to .0005", consistently.

Even caliper. The problem of uneven caliper is surprisingly widespread; a cold press veneering will often delaminate for this reason.

No tearout in OG edging. This is related to good IB, homogenous board, no particles in the core, etc.

Lack of abrasiveness. Some boards have a (negative) reputation for abrasiveness. This leads to short tool life.

Stability is very important since unstable boards make warped tops, usually after expensive work has been done on them.

Lack of a fuzzy, or dry, surface. Fuzzy boards cannot be glued or overlayed properly.

Consistent quality. Occasional problems are tolerant but frequent, volatile swings in quality, so that the buyer loses confidence in the general level of performance of the product, are intolerable.

Screw-holding, face and edge. This issue arises usually from other reasons, such as abnormally low IB.

Density. There is a generalized preference for lighter boards, e.g., 45 pounds or lower, for easier handling and lower freight costs. There is a sub-market requirement for higher density boards (55 or 60 lbs), but almost entirely if lower density boards can not do the job.

Embossability is a relatively recent requirement, restricted to perhaps a fourth to a third of MDF volume. Southern boards, almost all of hardwood, are preferred over softwood-based western MDF's.

MDF producers, like other wood products firms, must provide a number of marketing support services:

(1) **Advertising/Promotion to the trade.** Media advertising, trade show representation and a plant open house are useful to gain user awareness.

(2) **Claims.** An equitable claims settlement procedure is essential.

(3) **Cut-To-Size.** This is an extremely important commonplace in the sale of industrial particleboard, but relatively rarer in MDF plants. Those plants which do not have adequate cts capability must arrange for this through fabricators. The purchasing trend is definitely towards cts, as industrial firms seek to become less of fabricators, and more of assemblers, which enables them to expand capacity without parallel capital investment.

(4) **Product line.** This must include 4' and 5' widths, the former for construction and paneling uses, the latter for furniture and other industrial. Lengths of 8, 9 and 10' usually suffice although presses of 18' or 24' allow many variations. Common thicknesses range from 3/8 - 3/4" although presses with more daylight can make moldings. It is usually not economical for one plant to make a very wide range of thicknesses. In many cases MDF firrms charge a premium to make 4' panels on their 5' presses.

(5) **Credit.** Credit terms are reasonably well standardized throughout the industry, e.g., 2 percent cash of 10 days. Easier credit is not necessarily a marketing plus, although too rigid credit practices are a marketing minus.

(6) **Finishing.** Finishing is usually done by fabricators or the customer. One MDF producer sells a printed board, another sells a high-quality base-coated product for finishing via printing in the user's factory, and a third MDF supplier offers low-pressure overlays.

(7) **Local Stocks.** Eastern firms buying from the West Coast, conscious of the distance and the dangers inherent in delay of a carload, prefer but do not always get local fill-in inventory.

(8) **Materials Handling.** Loads must be strap-unitized, with protection for fine edges and corners.

(9) **Samples.** Samples are an important tool in selling, but the enthusiasm and interest created must be sustained by the product itself.

(10) **Technical Service.** All MDF boards exhibit some kind of problem from time to time, from blows or delamination to excessive abrasiveness. The supplier must have a competent representative, to determine and resolve the problem.

(11) **Truck Delivery.** A number of smaller firms are not on rail; therefore, truck delivery is not only desired, it is essential. For most producers of MDF, truck delivery represents a growing proportion of their sales.

Advantages and Disadvantages of Production in the Inland Region

As discussed in the section under particleboard, it is clear that there is no particular disadvantage to the Inland Region as a location for an MDF plant other than freight to major markets. There is, after all, an existing MDF plant (at Kalispell, Montana) within the region, which supplies customers throughout the U.S. and Canada. However, freight costs especially to the Southeast, are a major negative factor. An MDF with a density of about 44 lbs, about that of a good industrial particleboard, will be subject to the same tariffs, as shown in Tables 17-22. Freight charges to the major southern markets, both those in the Southeast and those in the Arkansas-Texas manufacturing center, range from $75 to more than $100. While freight to the Los Angeles area ranges from about $30 to about $60 per M, depending on location, there are two MDF plants closer to that market, one in Rocklin, California and one in Medford, Oregon. LGA judges it a severe, although not unsurmountable disadvantage, for an MDF plant not to have a substantial home market.

Allowable Wood Cost for an Inland Mill

Previous text established that the obtainable mill price for MDF at an Inland location is about $240. per M, 3/4". Production data from Comparative Economics of Manufacturing Composition Boards from Dead Timber indicate that the optimal plant would have a capacity of 70 million sq. ft. 3/4", or 300 tons/day, and employ a 5x18, 16 opening press. This plant would require capital (as of 5/79) of $23.8 million, actually $100,000 less than a plant operating solely on greenwood, because of savings in refining. Operating costs, including depreciation but excluding sales and ROI, are calculated at $125.36 per M.

LGA assumes sales expense of (5 percent x $240) $12. per M, while ROI at 30 percent before taxes equals $52.43. Thus total manufacturing and operational

costs are $190. per M. This allows a wood cost of $50 per M. at present prices, or $31.25 per o.d. ton, delivered millsite.

Market Volume and Probable Price Range in Year 2000

Both furniture and housing, the key markets on which MDF usage depends, should grow over the next two decades although there will obviously be periodic fluctuations. Currently, for example, high interest rates and the resulting disintermediation have slowed housing, and will affect cabinetry and furniture. Still, the long term trends are favorable, as depicted in earlier sections.

All indications are that MDF usage will continue to grow, although perhaps not at the optimistic rate forecast in the euphoric early 1970's. Available information indicates that MDF growth continued through the 1974-76 recession. However, the market share for each supplier either fell off or did not meet expectations, due to the enormous increase in new capacity coming on the market almost at the same time.

There has been only limited new capacity in the last couple of years, although several companies, as always, are examining the potential markets. One industrial particleboard plant was converted to MDF, and some plants expanded their capacity. Even a plant announced in, say, the next 6 months could hardly be built and running well before 1982.

At this writing, there are no such announcements or plants in pre-engineering in the United States of which we are aware.

Under such circumstances, the outlook for the industry is favorable. A combination of increasing furniture production, rising prices for hardwood lumber and thus increasing substitution by MDF, new designs which better utilize MDF, and the pressure of the industry's present plants to sell their output, all presage continued growth. LGA suggests a likelihood of an average growth rate of 4.5 percent per year through 2000, starting with 1979 as a base. The results of this expectation are that MDF shipments in 2000 will be about 1.5 billion sq.

ft. 3/4". The projection is considerably above present industry capacity of about 700 million sq. ft., 3/4". In order to supply this demand, 12 new plant equivalents will have to be built. These may be green field starts, or conversions from industrial particleboard plants or, to a limited extent, expansions of present plants, or all three. In view of the number of firms who have looked at this opportunity, LGA is confident the additional capacity will materialize.

LGA expects this continued market growth to come from all segments, with an increasing proportion coming from the "other" market, especially shelving, moldings of all sorts, stock panels, door parts and a number of other applications still being explored, including DIY markets. There should be a steady growth in furniture consumption, although MDF has already been tried in practically every feasible furniture application. Growth in kitchen cabinetry is likely to be more limited since this product less often requires the special capabilities of MDF.

Translating these assumptions into quantitative terms, LGA expects that in 2000, the broad furniture market will consume about 70 percent of the whole, or 1050 million sq. ft., 3/4". The kitchen cabinet market should take about 10 percent or 150 million sq. ft., 3/4".

"Other" uses should expand proportionately as well in volume and utilize 20 percent or 300 million sq. ft., 3/4".

Using the hypothetical Inland Region mill as a base point, the price range that LGA suggests for 2000 would be about $575. per M, ± $50.

Potential Share to the Inland Market

As already noted, the existing West Coast MDF plants, including the one in the Inland Region, already serve all the United States, although they do so at a severe freight disadvantage to the Southeast. Similarly, a new MDF plant would probably seek trade throughout the U.S. (and in Canada for that matter).

However, a plant located in the dead softwood region would have a more favorable access to about 6 percent of the market, which is relatively close-in. This would amount to, in 2000, about 90 million sq. ft., 3/4", or enough to support one plant. The market in the area west of the Mississippi would total about 22 percent of MDF requirements, or 330 million sq. ft. 3/4". LGA notes that there are already four plants west of the Mississippi, whose total capacity is 285 million sq. ft., so that any new plant would have to look to eastern markets to utilize all its capacity.

MISCELLANEOUS OPPORTUNITIES

In addition to the major product possibilities which could be made from dead softwoods, LGA was asked to explore on a preliminary basis and/or comment upon a number of other products or uses which could be made of this timber, based on a desk review of data available to the Cooperator.

THINBOARD

In recent years there has been an emerging concept of a "thinboard" product and market, considered somewhat separately from other reconstituted products or other panel products. As of this writing, the definitions of both product and markets are not clearly defined or widely accepted. For example, some "thinboards" are perceived as particleboards, while others are seen as medium density fiberboards. And, in fact, almost all hardboard fits the definition of "thinboard". Some publications imply that "thinboards" are equivalent to continuous process panelboards. Moreover, there is no unanimous consent as to what is "thin". Some publications consider board of 1/2" and under as thin. LGA prefers to restrict its consideration of this market to panels 1/4" and thinner.

There are a number of products already serving these markets in the United States. They include:

- ... particleboards
- ... hardboards
- ... medium density fiberboards
- ... hardwood plywood

Not all of the supply of these products, whether produced in North American or imported, falls into the 'thinboard' arena. For example, in the United States, the thinboard market is currently made up of:

> 4 billion sq. ft. 1/8" basis of hardboard, of which 850 million is wall paneling, 150 million tileboard, 750 million doorskins, while the balance is used in the furniture industry and a host of miscellaneous opportunities.

175 million sq. ft. 3/4" basis of thin particleboards, used for paneling, and furniture/cabinetry parts.

about 20 million sq. ft. of MDF, 3/4", used for furniture and cabinetry.

about 4½ billion sq. ft. surface measure of hardwood plywood of which about 1.6 billion is made domestically, usually from fine faces over various substrates, and 2½-3 billion is imported, either prefinished or 'in the white'.

The ostensible markets are very large, provided that a 'thinboard' is a performance and cost-effective alternative to hardboards and lauan plywoods. It is obvious that if another form of reconstituted panel can perform the functions now satisfied by hardboard at a lesser price it will obtain a significant share of the market.

It is not so clear that a reconstituted panel can replace lauan, although some surely is so replaceable. The limitations are that lauan can be designated as real wood veneer, even if overprinted with a grain pattern, while a reconstituted panel can not. Of course, a veneer can be overlaid on a thinboard substrate - which is now a common procedure.

In summary, LGA does not see a distinct market defined for thinboard which is materially different from those described in the chapters dealing with particleboard, hardboard and MDF. If such a product goes the MDF route, the capital costs and operating costs will be quite similar to those for a dry process hardboard plant, although such data were not provided to LGA. However, a word of caution seems advisable. Most of the 'thinboard' applications must find their markets at points quite distant from the dead softwood region. Thinner products are used as drawer sides and bottoms, as dust covers, or in drum construction, all in furniture and cabinetry, of which there is little in the region. It is also used as wall paneling, and for doorskins and other industrial uses, for which regional markets are minimal, as described before. Before specializing in the thinner panels, an otherwise feasible reconstituted panel opportunity must explore the regionally accessible market.

ENERGY

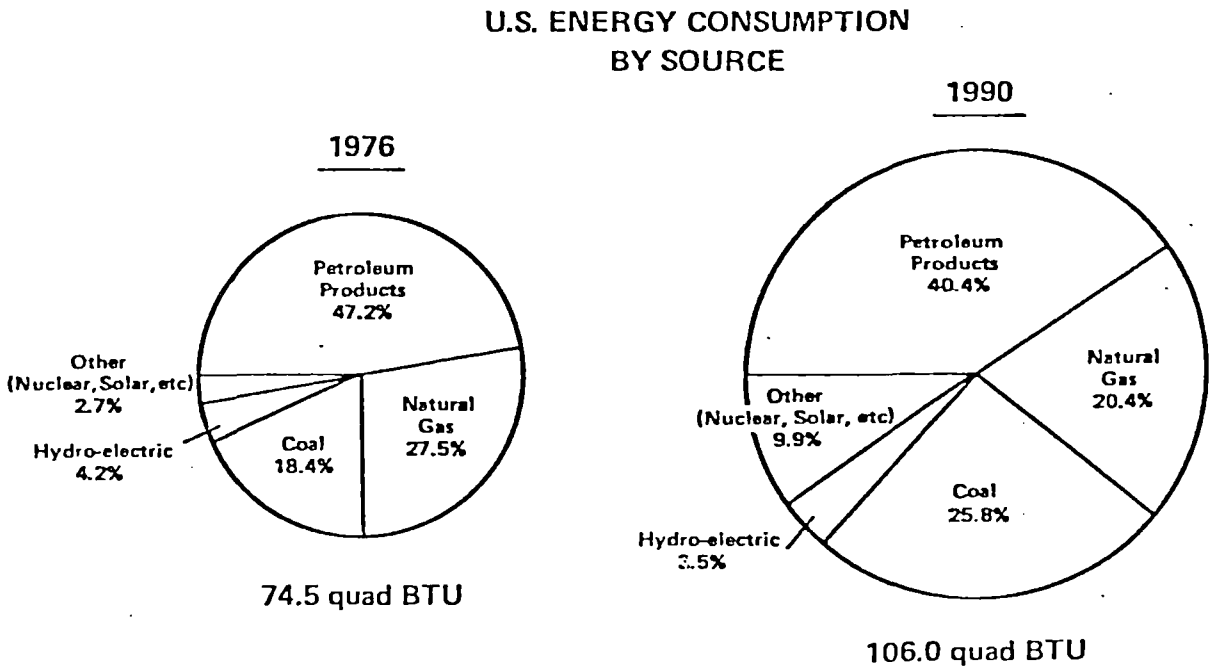
Of the millions of board feet of timber that have been ravaged by the Mountain pine beetle or killed by white pine blister rust, much is located in inaccessible roadless areas, where fire is one of the principal threats to the large areas of standing dead pine. With fire as a principal threat, it is obvious then that the material is suitable as fuel.

Technical studies at the University of Montana on chemical composition found no difference in the BTU content between greenwood and dead wood when an allowance had been made for the differences in moisture content. The moisture content in the dead logs might average between 15-20% compared to typcial moisture contents of 22-40% in green logs.

In considering wood for fuel we must bear in mind the present energy situation with increasing demand, rising fuel costs, and a threatened shortage of supply. Petroleum will have to play a smaller role in the future than it has in the past (See Figure 16). As a result then, serious consideration is being given to the use of wood and/or other biomass fuels to generate heat, produce steam, and/or generate electricity. A number of forest products companies have converted (actually, in some cases, reconverted) to burning wood residues to supply all or part of their in-plant needs for steam and heat. Other firms and businesses are also burning wood fuels for energy but, in those cases where they do not have fuel as a residue base created on the plant site for a source of supply, such conversions are somewhat more costly, difficult and often postponed.

The use of wood as an energy source compared to alternate fuels and supplies has both advantages and disadvantages. (See Table 47). On the positive side, wood is generally a clean burning material, leaving little sulphur residue, and only a low amount of ash residue, and in many cases is cheaper than oil. Wood in the western states is locally available, is a renewable source, and requires no foreign exchange. On the disadvantage side, the sources of wood are relatively scattered, and it is expensive to collect. The wood supply is generally not

Figure 16



Source: PREDICASTS

TABLE 47

BURNING WOOD FOR ENERGY - OR BIOMASS CONVERSION

ADVANTAGES	DISADVANTAGES
Clean - no sulfur	Scattered
Low ash	Expensive to collect
May be cheaper than oil	Non-homogenous in type-bark, leaves, wood
Cord of wood to steam	Non-homogenous in size - scrap, tops and branches, dust
$2.70 - $3.00 MMBTU	Wet
Locally available	Not handleable as a gas or fluid without work
Renewable	Supply could be interruptable - weather, strikes, fires, housing starts, mixed blessings of integrated mills
Creates a new industry	
Socially acceptable some places	
We own it	

homogenous in that it contains bark, needles, and dirt and it is usually non-homogenous in the size in which it is gathered. It contains substantial quantities of moisture, and it is a solid **non-flowing** product as opposed to the fossil fuels or the natural gases. The supply of the product can be interruptable due to weather conditions as well as strikes or fires.

There are three primary opportunities for using deadwood as an energy source: 1) fire wood, including man-made fireplace logs, 2) as a fuel for steam or electrical energy production on-site or industry plants and 3) as a fuel for a utility size power plant including co-generation.

1. Firewood

Worldwide, probably over 70 percent of all wood harvested is utilized for fuel purposes in cooking and heating at a relatively basic level. In the more developed nations the volume used as firewood is quite small. Firewood cutting permits on U.S.F.S. lands indicate that about 1 percent of the Forest Service timber is gathered for fuel wood.

Currently, in the forested areas of the western United States, there is a tremendous resurgence and interest in utilizing firewood for heating purposes to replace or supplement fossil or electric units. Thousands of homeowners are adding airtight wood stoves to existing homes for supplemental or, in fewer cases, for total heating. While the trend has appeared in the metropolitan areas, there is an even higher incidence of the addition of wood stoves, either freestanding or as a fireplace insert, in the suburban and rural areas. Merchants selling these units report shortages, with waiting lists for some popular models of up to several months. Imports of fuel wood heating stoves are dramatically increasing and new manufacturers of wood stove units are springing up across the country.

A high percentage of people putting in the supplemental wood heating systems, expect to harvest or collect and prepare their own supplies of firewood for these systems. Firewood prices as delivered by commercial wood dealers have

increased from $25-30 a cord, two years ago to $60-100 a cord for current deliveries, and even higher in some large metropolitan areas.

Little of this interest in firewood relies upon dead timber of the magnitude and scale covered in this study but much of the firewood supply does come from the natural attrition occuring in all healthy forests or from slash left after logging. The gathering, sawing, splitting, and delivering of firewood on a commercial basis is essentially craft oriented, often done as a part time venture. It is currently not an industrial enterprise, but rather more of a small business. Demand is heavily localized.

LGA certainly expects the interest in wood burning systems for home heat to continue to increase and use greater annual volumes. However, with the decentralized nature of the market, the cost of transporting from mill to market, and the small volumes used per household, the increase in the use of firewood for domestic heating will not offer any significant commercial opportunity for the major areas where large volumes of dead timber are standing.

Beyond the use of log sections as firewood, wood residues may be compressed to form **fireplace type logs.** Currently in the western states there are probably 20 or so different manufacturers using various wood residue sources, and compressing them into a solid log, sometimes using minor amounts of binders. There are also fireplace logs made of paper. These man-made fireplace logs are then packaged and distributed through grocery stores or other consumer outlets and sold to the consumer for fireplace logs. The production of fireplace logs is more of an industrial operation than is firewood gathering. Fireplace logs are usually a by-product operation at a wood products manufacturing firm. The man-made products are packaged and merchandised with consumer advertising. The manufactured fireplace logs are quite heavy and transportation costs prohibit moving them extensive distances. The use of fireplace logs and the method of marketing them rely primarily on their being accepted by the ultimate consumer as a convenience item. They are usually priced above firewood and are purchased by the package with groceries, rather than by the cord delivered to the home.

Manufactured fireplace logs currently sell at the production site for between 25 and 40¢ each depending on the weight, size and marketing program of the individual producer. This is equivalent to a range of $60-135 per ton, depending on product density. When freight and distribution markups are added, individual logs sell in grocery and other outlets reasonably near to the source of manufacture (350 miles) at retail from 50¢ to $1.00 each. Small fireplace log manufacturing facilities turn out about 60,000 logs a week, using perhaps a half million pounds of dry residue a week. Such a volume would generate the producing company or mill about $1.2 million dollars annually. A wide range of capital equipment and prices for the various systems are available but the smaller installations using new equipment can be put in place for perhaps a half million dollars.

LGA expects to see a modest increase in this manufactured log business in all the western states. However, the overall impact on the available volume of standing dead wood is negligible.

2. Energy Generation at Non-utility Plants

The use of wood fuel for the generation of steam for heat at forest products operations is quite common. The use is rising of wood fired boilers to provide heat for dryers and steam for pulping and other process operations. Prior to the 1973-74 period there had been a gradual reduction in the volume of wood burned for energy at wood products mills and plants as lower cost natural gas and oil had been taking over in supplying process heat. Following the 1974 sharp rises in fossil fuel prices, and general energy "shortages," new attention was focused on the utilization of residues as an energy source.

The utilization of wood for fuel by industrial firms, primarily forest products companies to generate energy, is still almost exclusively using residue type materials including bark and other non-chippable residues. Some installations utilize chippable waste. Most of these installations do not generate electrical energy by using steam generators, but a few do. Several wood products producers on the Indian reservations have installed electrical generation that not only meets the needs of the saw mill and forest products operations but also

supplies electricity to some of the housing and other facilities. Several remote area Alaskan forest products operations are also reported to be installing generating capabilities. The concept of co-generation, where high-pressure steam from wood fired boilers is used to generate electricity with the low pressure steam returned for use in process activities has new interest. The Weyerhaueser Company at Springfield, Oregon, in conjunction with the Eugene Water and Electric Board have developed such a facility recently. Similar arrangements are under study between Pacific Gas and Electric Company and the Louisiana-Pacific Corporation dealing with a plant site at Oroville, California. [1]

To date, most of these energy development opportunities have been involved with residue disposals. Wood is cost effective in providing BTU's in comparison with coal and fossil fuels when no harvesting costs are involved.

Another new development affecting wood use as a fuel is the development of pelletized fuels, e.g., Woodex, which converts many types of fibrous organic material into a fuel pellet that burns cleanly and requires only a minimum of conversions to serve in existing industrial boilers. The patented Woodex process is oriented towards the use of waste, but has the advantage that pelletizing plants can be constructed relatively economically on small plant sites. The output fuel can be easily transported and can be utilized in a wide variety of industrial boilers and other heating plants. The Woodex process is reported to increase the burning efficiency by its promoters. Two existing western operations include a facility by the Hines Lumber Company in Hines, Oregon, and by the Sierra Power Corporation in Freson, California. An additional plant is under construction in Sandpoint, Idaho, and there are another half-dozen plants around the United States and more being constructed overseas and in Canada.

LGA believes there will be many more plants in the western states converting to the use of wood for fuel in the next 5 years.

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[1] Grantham, op.cit. in Bibliography

3. Large Scale Wood Burning Energy Plants

Currently there are no major western enterprises set up solely for the purpose of producing commercial energy from timber or wood mill residue. The economics have up to now precluded such operations. In the Mountain states, the primary competitive fuel to wood for electrical generation will be coal. While in many cases, mill residues can be provided to a coal generating electrical plant at a lower cost than coal, when the harvesting and collecting of standing timber is added to the cost of providing a wood fuel, wood is a more expensive fuel and hence it has not been utilized.

Another important consideration relates to the volume of fuel needed to operate a modern, cost-efficient, energy-generating station. These installations, like modern pulp mills, to be efficient, must be large and highly automated to minimize the amount of labor utilized. Since such plants operate seven days a week, the automation of a single function that eliminates one position, in effect, reduces the need for four employees who would be required to man that position around the clock seven days a week. The net result is, of course, that these large facilities utilize enormous volumes of fuels. To illustrate the quantity involved, the Pacific Power & Light Company has a coal fired mine mouth generating plant in Centralia, Washington. This plant was built about 1970 and an estimate of its capital cost in 1979 dollars is $850 million. Its output is 1,300 megawatts and it uses 20,000 tons/day of coal as fuel. Over a 25-year life cycle this is over 180 million tons of coal, or somewhere around 5.5 billion board feet of timber.

Further, since these plants are constructed with planned 25 year life cycles, they require tremendous volumes of **assured** future raw materials to be economically feasible. To date, there are no available supplies of wood raw materials that can be committed to supplying such a plant at any cost and hence, the interest on the part of utilities to go this route is minimal. The more likely occurrence in the near future for the use of wood fuels in generation by electrical companies would be to utilize some wood fuel perhaps pellitized in conjunction with the coal utilized in an existing facility. Also, LGA believes there may be isolated

opportunities within the Mountain states where smaller generating facilities can be established to supply local needs at reasonably competitive costs to available supplies using wood fuels.

AN INDEPENDENT FINISHING PLANT

Most reconstituted panels are eventually finished by one means or another. The usual forms of finishing employed today are the following:

hardwood veneer
print
high pressure laminates
low pressure overlays
vinyl film or sheet
painting

Hardwood Veneer

This old art is usually applied to MDF or industrial particleboard to provide a premium surface. Hardwood veneers have been glued to hardwood lumber, hardwood plywood cores or softwood plywood cores for many years. Hardwood veneer is usually applied to thicker reconstituted panels, used in finer furniture and cabinetry, and to thinner panels also employed in those industrial applications, but not for wall paneling, for which a plywood substrate is more common.

As hardwood of finer and rarer species has become more expensive, the surface veneers have been sliced thinner and thinner (up to 1/100" is produced, although thicker slices are more common). These very thin veneers are subject to telegraphing the defects of the substrate. Therefore a crossband of veneer or some form of paper or fiber product is often used, where veneer is layed on industrial particleboards. One of the virtues of MDF is that its surface smoothness is such as to eliminate the need for crossbanding, saving considerable sums.

Hardwood veneer is usually applied by the furniture or cabinetry manufacturer in his own plant, and represents a highly skilled art. There are a few fabricators who apply veneer to reconstituted parts. There is also a subsegment of the industry producing 'stock panels', a number of firms mostly in the Pacific Northwest who overlay purchased hardwood veneers on softwood plywood or, recently, MDF cores to make 4x8 panels, mostly 3/4", for sale to small cabinet shops. After a number of declining years there is evidence the consumer preference is generating increased veneer usage, although supplies are limited.

Print

Direct printing requires a premium surface, smooth and light colored. With printing, which may include some form of embossing/distressing, almost any color or texture of fine wood may be produced. Because of the demands of good printing, MDF is commonly printed, industrial particleboards less so. In any case, the sanded panel is often flood coated with a polyester or other base case, which is polymerized by heat or RF. When printed, a top coat is often applied of the same type, or another protective glaze.

Because of the enormous variety of colors and species patterns, printed board is rarely provided, in finished form, by the reconstituted panel producer. Some producers do offer intermediary products; they may be base coated, or even have a grain printed on them, requiring only color toning by the customer. Most printing is done by the furniture/kitchen cabinet firm, although there are finishers with print lines. This is probably the fastest growing form of surface finishing.

High Pressure Laminates

These products are usually made in panel form, using either melamine or phenolic resins, under well known consumer brand names. They make the least demands upon the reconstituted substrate since they are abrasion resistant and so thick as to bridge any surface roughness; therefore the least expensive particleboards are often used, such as underlayment grades. Most of this product

is applied on a construction site, as kitchen countertop, or wall covering. Some is used in the manufacture of such items as dinettes or vanities. High pressure laminates are not sold by a reconstituted panel producer, since the resulting panel would create much waste and be difficult to work.

Low Pressure Overlays

There are several types of low pressure overlays, including melamine, phenolic and polyester, of the more prominent ones, as well as paper overlays impregnated with diallylphthalate, etc. In contrast to the high pressure laminates, which are made as separate panels and then bonded to a substrate, the low pressure overlays are formed when a resin impregnated, patterned sheet of paper is heat and pressure fused to the substrate, on one or both faces. Such products offer considerable abrasion resistance, although less than high pressure laminates.

Low pressure overlays are used for shelving, furniture and cabinetry, and have gained a growing acceptance. The machinery to make these is found at all levels: board producer, fabricator/finisher and industrial customer. Since the manufacture of melamine overlays requires a higher capital investment, this is more commonly produced by the particleboard producer, while polyester is more commonly found at the intermediary or user level.

Vinyl

Vinyl film or semi-rigid sheet is perhaps the least expensive overlay, often used for wall paneling, or for less expensive kitchen cabinetry or furniture. Its abrasion resistance is lower than the melamine or polyester surfaces, so vinyl is rarely used on horizontal, wearing surfaces.

Vinyl is best known for its flexibility, as in mitre-folding. In this process the vinyl overlayed panel is back cut to just clear the vinyl, so that the panel sections can be folded to form a box whose edges are continuously overlayed with vinyl. This is frequently used on inexpensive stereo and electronic

cabinetry, as well as the other products mentioned. The major demand that the use of vinyl makes is for a clean cutting board; generally any industrial or good underlayment particleboard will do.

Vinyl's growth seems to have leveled off in recent years, with the rebirth of interest in veneers and higher valued products. The expense of a high capital investment vinyl line is such that it is usually found at the mill level, and not at the user level.

Paint

Some reconstituted panels are simply spray or roller coated with a water or oil based paint, as in the inside surface of some kitchen cabinetry, or shelving. This is the least expensive finishing, and may be applied by an intermediary firm or the user, rarely by the board producer.

Relation to Dead Softwood

LGA believes there is no direct connection of any finishing method with dead softwood products. If a mill, making a reconstituted product as described in earlier sections, proves economically feasible, one of the considerations is whether it should have one or more finishing methods - some mills have two or three, some have none. Unlike cut-to-size, which is a requirement for a mill serving the industrial market, the justification for a finishing line will depend on the specifics of the products to be made and the markets served. No finishing is required. However, it seems reasonable that a product line containing a base coated panel, perhaps with a grain printed upon it, would be desired by the market.

MOLDED PRODUCTS

Molded wood products ventures are few, and are proprietary in nature. Thus little information is published dealing with process or markets, or with the

capital and operating costs associated with such products. LGA has identified two categories, which encompass most of the field. Other, quite small ventures exist.

Werzalit Products

Werzalit is the registered trademark of J. F. Werz, Jr., KG, Oberstenfeld, and is used to designate the process and the products made from it. There are three plants in Germany and 22 licensees worldwide making a wide variety of products, including kitchen countertops and cabinetry, furniture parts, wall and ceiling tiles, industrial parts, and many more.

In this process, wood residues or chips are converted into specific sized wood flakes, with resins then blended to form the basic furnish. The furnish is moved into a die, and by the application of heat and pressure, the mixture is cured, forming a shaped product. A frequently used variation for adding resin-impregnated decorative top and bottom sheets. These are then fused with the particleboard core in a one-step preparation.

Currently there are two Werzalit plants east of the Mississippi; one make furniture and miscellaneous parts in Bradford, PA, and the other is just starting to produce pallets, in Dover, Ohio. The proven market for the product is limited in size to the capacities of these two plants. However, the pallet firm is optimistic that its market is larger than it can supply. A typical installation involves a single press line, making 250 pallets per shift. On a three-shift basis, this would be 750 pallets a day, or about 187,500 pallets annually. Each pallet weighs about 35 pounds and would require about 3,250 tons of wood for each press line. At an average sale price of $5.50 a pallet, the annual sales per line would be just a little over $1 million.

Reliable capital cost data are not available on such a molded pallet plant, although LGA understands that the investment should range between $6-8 million. If the product is successful there will probably be other pallet plants established.

This concept is not significant in terms of wood utilization in the dead softwood region since the volume of about 10 tons per day would not utilize much of the available resource. It has not been established that dead softwood can be used for this purpose, although LGA sees no reason to believe that it can not.

Molded Doorskins

Currently there are three firms producing molded doorskins at four locations in the United States: Weyerhaeuser, Masonite, and the largest producer, Jeld-Wen, an independent door company in Klamath Falls, Oregon. Molded doorskins are die-pressed from a fiber and resin furnish, similar to the Werzalit process. After pressing, the doorskins are assembled onto frames in flush door plants, usually for interior uses in new residential construction and the repair and remodeling aftermarkets. In appearance the molded doorskin resembles more expensive stile and rail doors. Wood panel doors are made primarily in the Pacific Northwest, and only a few panel door plants, utilizing pine lumber, are located elsewhere. Stile and rail appearing doors sell best in conjunciton with colonial styling, and residents of the southern states have always been leading consumers of this type of interior door. The door can be made and marketed profitably at costs substantially below the real panel doors. A true panel door, of course, has the advantage that it can be stained, whereas the molded door must be painted.

A typical investment of six to eight million dollars should produce about a hundred tons a day of product, and a press line would cost about one and a half to two million dollars. Overall, it appears that there is a growing market for this kind of product. Of course it is necessary to ensure that a satisfactory supply of raw material is available, and that dead softwood would be successful in this application.

This is a specialty product whose technology is available openly. Any manufacturer other than the three firms currently engaged in the business would first have to develop the process technology, and then obtain markets for the doorskins. On this basis, LGA is not optimistic about the potential for a new firm in the dead softwood region. Of course, a manufacturer already in the field could well establish a facility in the region.

THERMO-MECHANICAL PULP

This may be a promising option although there may be some difficulty in pulping dead softwood. Maloney, et.al, report:

"The technical feasibility of using beetle-killed ponderosa pine for pulp and paper products depends on the effects of moisture content, blue-stain fungi and deterioration by decay, on the quality and yield of pulp and on the consumption of chemicals. Information on the combined effects of these factors is scarce.....The pulp yield and strength from blue-stain fungi infested wood is not known. Needless to say, (substantial) decay in wood would seriously reduce both yield and quality of the pulp.....evidence (from previous studies) makes pulping seem infeasible. Further study should be undertaken to verify the results of this preliminary study. It is obvious that the degree of decay will affect the acceptability of beetle-killed ponderosa pine wood for pulping; however, blue stain alone should not prevent use of this raw material for pulp and paper..... Further pulping studies may be needed to provide answers to specific pulping problems.

At the present time some mill residue is being chipped and shipped from the dead softwood region to pulp mills in the Lake States but increasing shipping costs are making this a less attractive alternative. A pulp mill nearer the raw material may be a consideration. The high capital cost of a pulp mill, large water requirements, and pollution hazards all militate against conventional kraft or sulfite installations. The Front Range situation would require a pulping method which has low water requirements, minimal pollution hazards, and a smaller capital investment."

However, sellers of dead softwood report that it is used to make kraft pulps, with little problem. Other studies (FPL) show good pulping characteristics of dead spruce and pine.

The only pulping methodology which seems to be able to meet these diverse requirements is thermo-mechanical pulping (TMP). This refined groundwood process has experienced the sharpest upsurge of any form of pulping, with more than 100 installations of worldwide, and many more under construction. It

combines relatively low capital investment, high yield, low water requirements, and strong pulp which can be used, singly or in combination with other pulps, to make many products. However, there are only two freestanding TMP mills in North America selling market pulp; all the rest are owned by integrated firms which consume their output in the manufacture of finished paper products.

The process consists of fiberizing chips under pressure which have been soaked in hot water. A minimum freestanding plant would require 300 ADST per day, or two fiberizing lines of 150 tons/day each. Power requirements would be about 27,500 KW, whether purchased or generated; process water required is about 1-1½ million gallons per day, free of turbidity. Process water requirements can be greatly reduced by recycling. Effluent would, of course, have to be treated.

LGA has obtained rough estimates of capital costs, at about $100,000 per daily ton of output. Thus a 300 t/d mill would cost $30 million, plus the cost of power generation if not purchaseable. However, ROI can not be calculated at this time since detailed capital and operating cost data are not available.

Freight costs are important in pulp shipping and marketing, since it is a bulky product. This is a common concern of the three pulp mills now in the dead softwood region (Missoula, Lewiston, and Spokane). The likeliest markets would be found in paper mills located in the close-in states. There are almost two score paper mills in Washington, Oregon, Idaho, Montana, and Colorado, most of which make papers in which TMP could be utilized. During the course of the freight analysis LGA obtained tariff information on the costs of shipping pulp to identified markets. These data are presented in this section in Tables 48-54, in case further economic opportunity analysis is desired at some future time.

For the present, LGA concludes that TMP is a promising opportunity on a preliminary basis.

Table 48

CARLOAD RATES APPLYING ON WOODPULP

From Denver, Colorado

effective 10/15/79

TO:	Carload Rates in cents per 100 Pounds (CWT)
Chicago, IL	214 / 120,000#
Houston, TX	233 / 150,000#
Jasper, IN	197 / 120,000#
Kansas City, MO	161 / 120,000#
Los Angeles, CA	332 / 120,000#
Minneapolis, MN	190 / 120,000#
Winston-Salem, NC	223 / 120,000#

Table 49

CARLOAD RATES APPLYING ON WOODPULP

From Rapid City, South Dakota

effective 10/15/79

TO:	Carload Rates in cents per 100 Pounds (CWT)
Chicago, IL	200 / 120,000#
Houston, TX	275 / 150,000#
Jasper, IN	197 / 120,000#
Kansas City, MO	169 / 120,000#
Los Angeles, CA	332 / 120,000#
Minneapolis, MN	160 / 120,000#
Winston-Salem, NC	220 / 120,000#

Table 50

CARLOAD RATES APPLYING ON WOODPULP

From Missoula, Montana

effective 10/15/79

TO:	Carload Rates in cents per 100 Pounds (CWT)
Chicago, IL	264 / 150,000#
Houston, TX	306 / 120,000#
Jasper, IN	258 / 150,000#
Kansas City, MO	279 / 120,000#
Los Angeles, CA	a- 225 / 120,000#
Minneapolis, MN	279 / 120,000#
Winston-Salem, NC	226 / 120,000#

a- Applies only from Billings, Montana
Railroads may publish similar rates.

Table 51

CARLOAD RATES APPLYING ON WOODPULP

From Boise, Idaho

effective 10/15/79

TO:	Carload Rates in cents per 100 Pounds (CWT)
Chicago, IL	264 / 150,000#
Houston, TX	306 / 120,000#
Jasper, IN	258 / 150,000#
Kansas City, MO	279 / 120,000#
Los Angeles, CA	a- 191 / 120,000#
Minneapolis, MN	279 / 120,000#
Winston-Salem, NC	226 / 120,000#

a- Applies only from Lewiston, ID.
Railroads may publish similar rates.

Table 52

CARLOAD RATES APPLYING ON WOODPULP

From Chester, California

effective 10/15/79

TO:	Carload Rates in cents per 100 Pounds (CWT)
Chicago, IL	245 / 120,000#
Houston, TX	257 / 120,000#
Jasper, IN	256 / 150,000#
Kansas City, MO	234 / 120,000#
Los Angeles, CA	a- 299 / 50,000#
Minneapolis, MN	234 / 120,000#
Winston-Salem, NC	226 / 120,000#

a- Class Rates, Railroads should publish lower rates.

Table 53

CARLOAD RATES APPLYING ON WOODPULP

From LaGrande, Oregon

effective 10/15/79

TO:	Carload Rates in cents per 100 Pounds (CWT)
Chicago, IL	264 / 150,000#
Houston, TX	306 / 120,000#
Jasper, IN	258 / 150,000#
Kansas City, MO	279 / 120,000#
Los Angeles, CA	a- 469 / 50,000
Minneapolis, MN	279 / 120,000#
Winston-Salem, NC	226 / 120,000#

a- Class Rates, Railroads should publish lower rates.

Appendix A

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